WATER COOLER

CAD/CAM PROJECT

Course code : MED 314

By :

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Acknowledgement

We would like to express our special thanks of gratitude to Professor Ganesh Thangaraj Ponniah as well as our lab instructor Mr. Amit Kumar who gave us the golden opportunity to do this wonderful project on the topic Water Cooler, which also helped us in doing a lot of Research and we came to know about so many new things and we are really thankful to them.

CONTENTS

WATER COOLER

A water cooler or water dispenser is a device that cools and dispenses water

They are generally broken up in two categories: bottleless and bottled water coolers.

Bottleless water coolers are connected to a water supply, while bottled water coolers require delivery (or self-pick-up) of water in large bottles from vendors.

Water cooler may also refer to a primitive device for keeping water cool

Structural Parts of a water cooler

- Top Lid
- Front Top
- Rear Top
- Water Tank
- Chiller Base
- Front Bottom
- Rear Bottom
- Base Plate
- Dip Tray

Interior Parts of the water cooler

- Condenser Coil
- Compressor
- Motor
- Fan
- Dryer
- Inner Angle
- Capillary
- Thermostat
- Float Ball
- Mesh

External Parts of a Water cooler

FUNCTION OF VARIOUS PARTS:

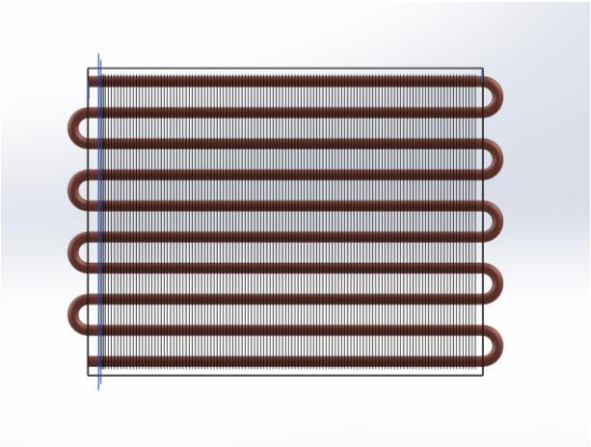
CONDENSER COIL:

In systems involving heat transfer, a condenser is a device or unit used to condense a substance from its gaseous to its liquid state, by cooling it. In doing so, the latent heat is given up by the substance and transferred to the surrounding environment.

Condensers Coils are heat exchangers designed to remove the heat absorbed by the refrigerant and heat of compression added to the refrigerant vapour discharged by the compressor to some external cooling medium, usually water or air.

Only then can the refrigerant be sent back to the cooling cycle or else there would be a drop in efficiency. Condenser cools the refrigerant to a temperature below the ambient temperature so that it can be easily cooled to the desired temperature rather than cooling it from room temperature or the inlet water’s temperature.

As a result the vapour refrigerant condenses back to liquid at constant pressure. Thus the function of a condenser is to get rid of the heat absorbed previously and re-liquefy the refrigerant.



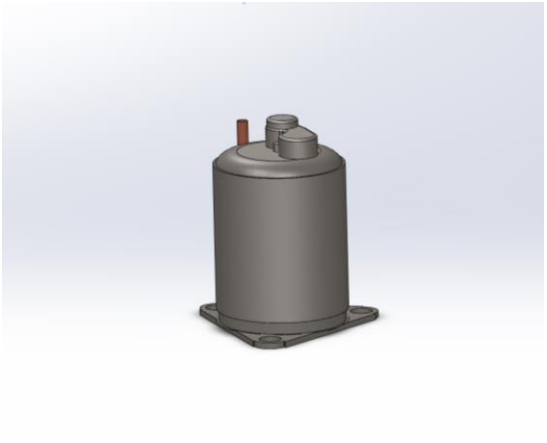
COMPRESSOR:

A compressor is a mechanical device that increases the pressure of a gas by reducing its volume.

Compressors are similar to pumps: both increase the pressure on a fluid and can transport the fluid through a pipe.

As gases are compressible, the compressor also reduces the volume of a gas.

Liquids are relatively incompressible; while some can be compressed, the main action of a pump is to pressurize and transport liquids.



MOTOR

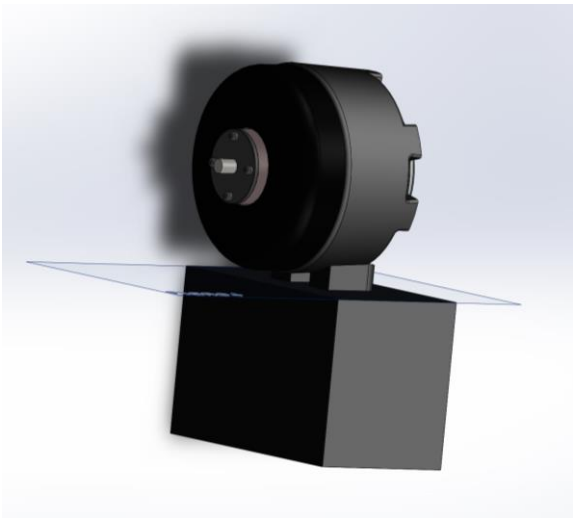
An electric motor is an electrical machine that converts electrical energy into mechanical energy.

Most electric motors operate through the interaction between an electric motor's magnetic field and winding currents to generate force.

General-purpose motors with highly standardized dimensions and characteristics provide convenient mechanical power for industrial use.

The very basic principal of functioning of an electrical motor lies on the fact that force is experienced in the

direction perpendicular to magnetic field and the current, when field and current are made to interact with each other.

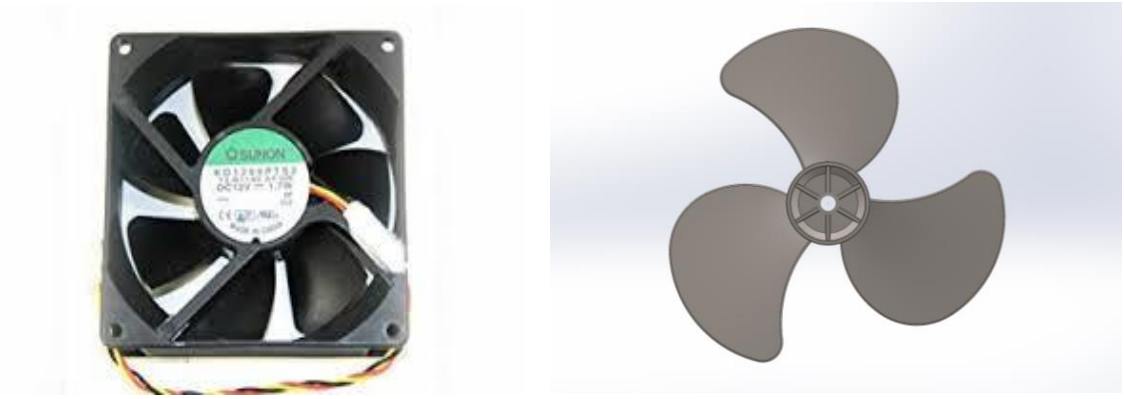


FAN

Fan’s function is to move the air across the condenser coil to cool the refrigerant, and change it from a hot gas into a liquid.

A condenser unit typically has a heat exchanger section to cool down and condense incoming refrigerant vapor into liquid, a compressor to raise the pressure of the refrigerant and move it along, and a fan for blowing

outside air through the heat exchanger section to cool the refrigerant inside.



THERMOSTAT

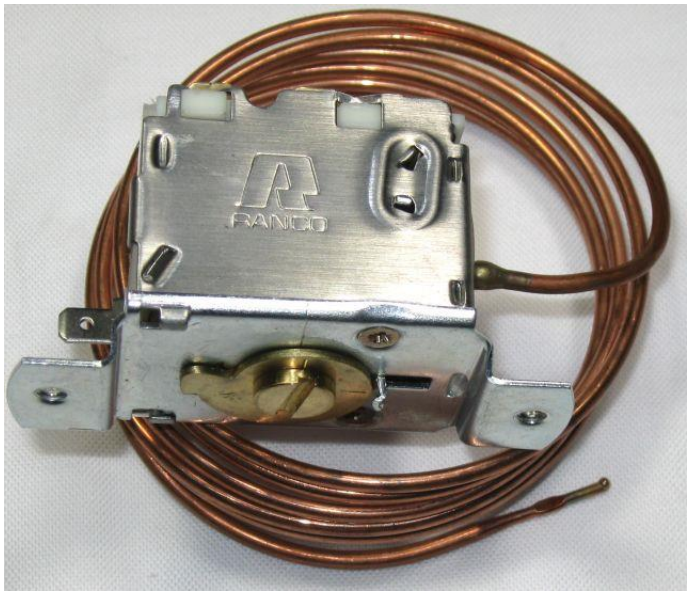
A thermostat is a component which senses the temperature of a system so that the system's temperature is maintained near a desired *setpoint*.

A thermostat simply switches the heating system on and off as necessary.

It works by sensing the air temperature, switching on the heating when the air temperature falls below the thermostat setting, and switching it off once this set temperature has been reached.

A thermostat can often be the main control unit for a heating or cooling system, in applications ranging from ambient air control, to such as automotive coolant control, but is also used in many other applications

A thermostat exerts control by switching heating or cooling devices on or off, or by regulating the flow of a heat transfer fluid as needed, to maintain the correct temperature. Thermostats are used in any device or system that heats or cools to a set-point temperature.



FLOAT BALL

One of the methods used to control the flow of water into water cisterns and tanks is the use of ball (aka float) valves.

Put simply, a float on the water inside a cistern or tank is attached to an arm which operates a valve which controls the inflow of water.

As the water level in the tank drops, the arm falls and opens the valve to allow water to enter the tank.

Then as the water flows in, the water level rises, as does the ball thus moving the arm which then closes the valve shutting off the water flow.

CAPILLARY TUBE

A capillary tube is a hollow pipe of thin cross section. It's purpose in the water cooler is to further bring down the temperature of the refrigerant gas. This is caused by the reduction of pressure after the gas flows out of the thin cross sectioned capillary into the larger cross section of the copper tube wound around the tank. The area increase is significant and so is the temperature drop.

Specifications of sheet metal used

• The structural parts of the water cooler are made of sheet metal of various thickness and materials.

• The front top, rear top, side panels, front bottom, rear bottom, dip tray and top lid are made of S.S. grade-304, thickness- 0.8mm.

• The water tank is made of S.S. grade 304, thickness-0.5mm.

• The chiller base’s material is G.P. of thickness 0.5mm.
• The base plate made of G.I. has a thickness of 1.5mm.

Why SS grade 304?

SS 304 stainless steel also known as A2 stainless steel (not the same as A2 tool steel) or 18/8 stainless steel, European norm 1.4301, is the most common stainless steel.

The steel contains both chromium (usually 18%) and nickel (usually 8%) metals as the main non-iron constituents. It is an austenite steel. It is not very electrically or thermally conductive and is non-magnetic. It has a higher corrosion resistance than regular steel and is widely used because of the ease in which it is formed into various shapes. It contains 17.5–20% chromium, 8–11% nickel, and less than 0.08% carbon, 2% manganese, 1% silicon, 0.045% phosphorus and 0.03% sulfur.

Manufacturing of Structural Parts

• First, the metal sheets are punched using the CNC machine in order to get the required dimensions and holes in 2-D.

• Next, the sheets are bent by the bending machine at various angles to obtain the 3-D structure.

What is a CNC Machine?

Computer numerical control (CNC) is the automation of machine tools by means of computers executing pre-programmed sequences of machine control commands. This is in contrast to machines that are manually controlled by hand wheels or levers, or mechanically automated by cams alone.

In modern CNC systems, the design of a mechanical part and its manufacturing program is highly automated. The part's mechanical dimensions are defined using computer-aided design (CAD) software, and then

translated into manufacturing directives by computer-aided manufacturing (CAM) software. The resulting directives are transformed (by "post processor" software) into the specific commands necessary for a particular machine to produce the component, and then loaded into the CNC machine.

Construction of Water Tank

The water tank requires a coiling of copper (outer dia-3/8 or 9.52mm) of 0.5mm thickness through which the cooling gas flows.

The thermostat pipe is attached to the base of tank with the help of a header. Thermostat senses and regulates the water temperature.

Tank is made by radius bending of sheet metal around a horizontal cylinder (which has a 75 degree bend) at specific markings.

Then the bent tank is spot welded by copper electrodes to join the bent structure at 5-7 equidistant (roughly) spots.

After spot welding, the remaining lining is seam welded to close the structure.

Seam welding is continuous and it seals the tank to avoid any leakage. It has 2 rotating copper electrodes through which the tank is passed at the joining edges. There is continuous water (coolant) running over the seam welding machine to cool the machine (and tank) down while it is welded.

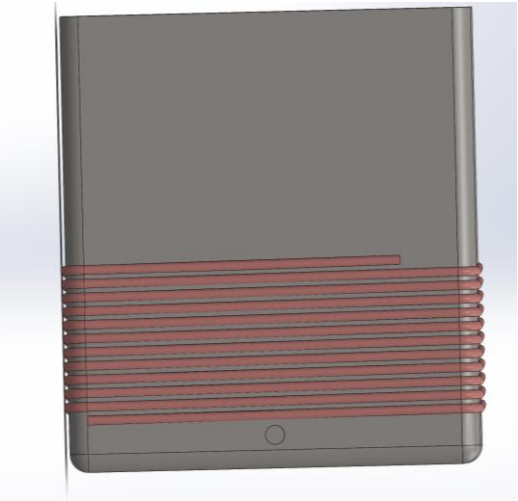
The seam welded edges are flattened by the help of a hammer and the tank is shaped.

Any sharp edges which are caused as a result of seam welding are taken care of by grinding.

Copper coil is wound around tank through which nitrogen gas is passed.

The tank’s coil is filled with nitrogen gas (N2) to test any leakages and to prevent the coil from shrinking.The

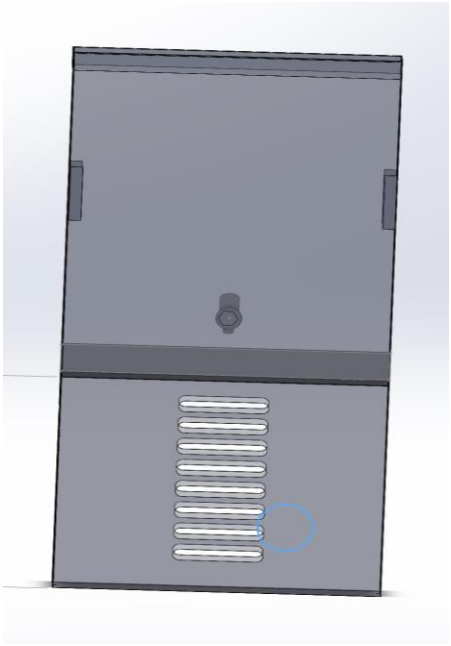
tank is washed, buffed to remove stains, and K2 (Comprising HF, HNO3, surfactants and inhibitors) process is applied for smoothening of tank's finish.



ASSEMBLY AND PROCEDURE

• First, the side panels are attached to the chiller base by rivets.

• Next, the front top is fixed to the chiller base followed by the rear top. The tops are then attached to the side panels using an L plate and screws.



• 2 channels are fixed at the bottom of the chiller plate to support the heavy water tank and balance the structure.

• Before fitting the tank in, nitrogen gas is let out and checked for leakages.

• The tank is then fit in by connecters, 2 of which connect it to the lower part of the front top where 2 taps are to be attached. 1 connecter connects the tank to the lower part of the rear top

3(for tank cleaning) and 2 to the upper part of the rear top (for water inlet and overflow).

• After fitting the tank, a chemical called puff which contains a combination of ISO (62%) and Polyol (38%)

is added between the tank and the outer body via the chiller base. Puff insulates the tank and helps the tank stay cool by forming a sponge like material.
• 4 inner angles are used to attach the base plate, side panel and chiller base. Their purpose is to distribute the weight of the cooler so that it doesn't collapse.

• On the base plate, the condenser coil is fixed on the rear side with the help of 2 nut sets and screws.
• Similarly, the reciprocating compressor is fixed on the base plate's front side.

• 2 capillaries made of copper (0.06mm inner dia) and a charging pipe are attached to the dryer's upper end; the lower end has an opening called dryer opening which is attached to the condenser coil's header via dryer connection pipe.

• The other end of the capillaries are attached to the tank's copper coil.

• 1 opening (left) of the compressor is used to fix the charging pipe the other 2 openings (right) fix the section (lower) and the discharge (upper).

• The section pipe is covered with an insulation pipe and is attached to the tank's coil for return of gas.
• Discharge pipe's other end is attached to the condenser coil.

• The motor's mounting with the motor (PSC/CSCR) is attached to the base between the condenser coil and the compressor. A fan is fixed on the motor to cool the condenser coil.

• The thermostat, motor and compressor are wired using harness and thimbles, thermostat is inserted in thermostat pipe.

Note: The rated frequency of the cooler is 50Hz and the applied voltage is 230 volts.

• The front and rear bottoms are fixed to close the structure of the water cooler and the taps are attached along with the dip tray.

• A mesh (top left of rear of tank) for overflow and a float ball (top right of rear of tank) at the water inlet are attached. The float ball shuts the water supply when the tank is almost full.

• The cooler is then sent for testing its cooling capacity and errors.

• Finally, the top lid is fixed to close the structure.

WORKING AND REFRIGERATION PROCESS

• The water cooler works on the principle of gas pressure system.

• R-22 gas of 900gms flows into the system and cools the tank.

• The gas is compressed by the compressor to reach 43.3 degree Celsius at a high pressure and passed through the condenser coil via the discharge pipe.

• A fan is used to cool the condenser coil and drop the temperature. The condenser coil condenses the refrigerant gas into a liquid.

• The liquefied gas which is then passed through the long capillaries via the dryer (which absorbs all moisture) undergoes high pressure due to extremely thin cross section.

• This pressure is reduced by the increase in cross section as the gas flows into the copper coil of the tank. (P=F/A)

• The reduction in pressure leads to a sharp drop in the temperature of the R-22 gas (16 degrees). (PV=nRT)

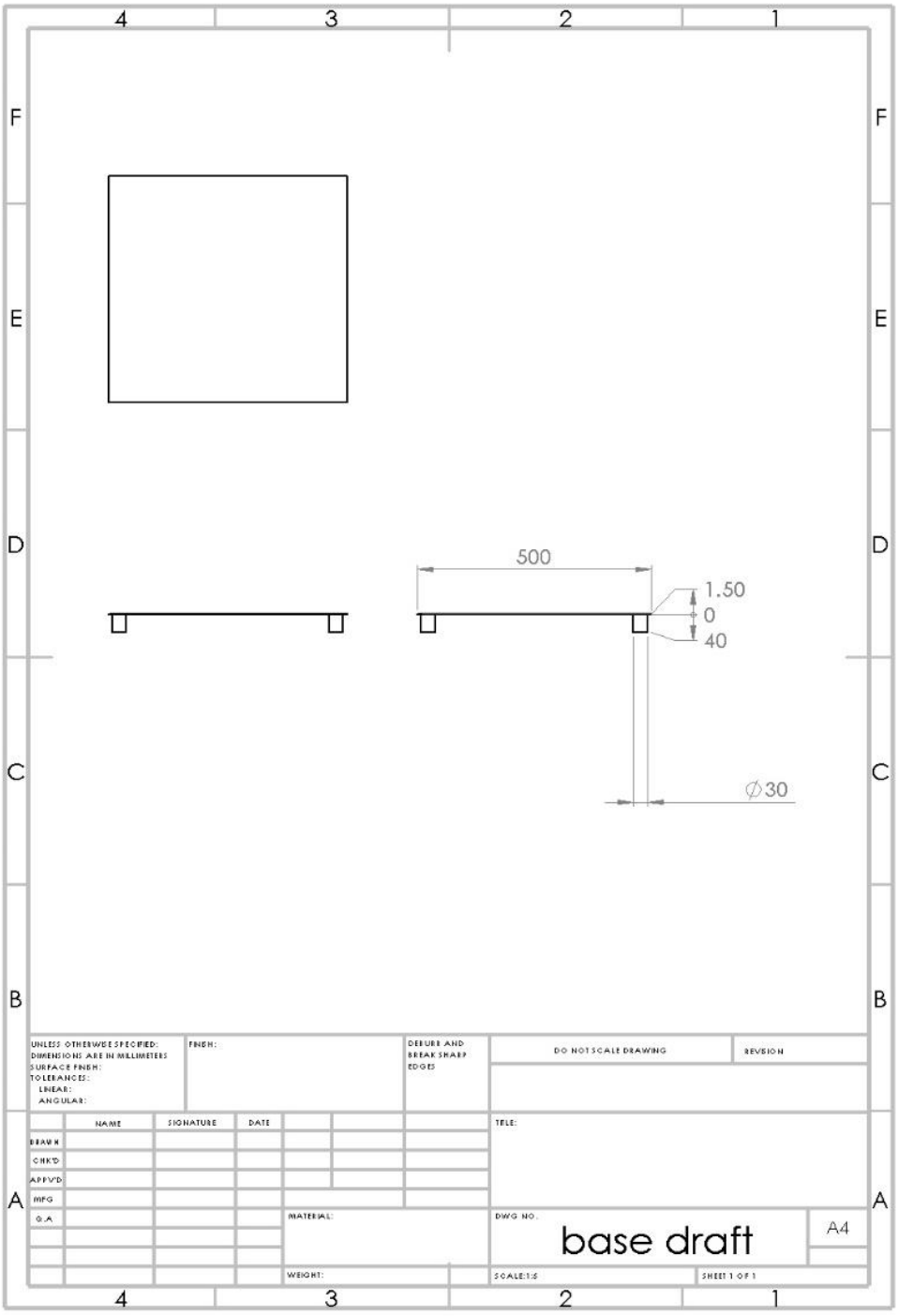
• This cold gas passes through the copper coil of the tank and returns to the compressor via the section pipe at a return gas temperature of 18.3 degree Celsius.

• This cycle continues and results in the cooling of water inside the tank.

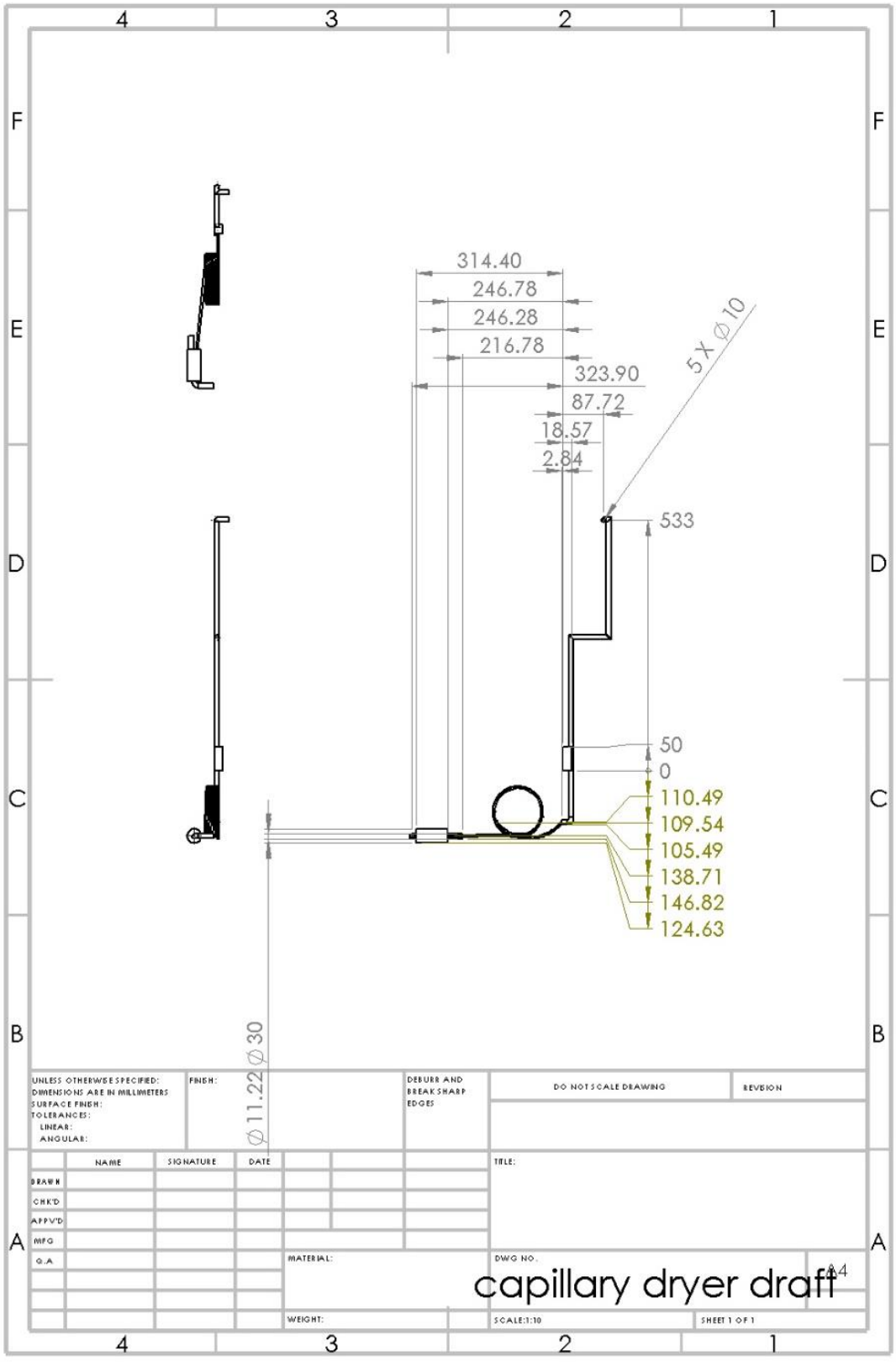
• A thermostat, whose capillaries are attached to the tank via the thermostat pipe senses the temperature and regulates it according to our need.

Draft of CAD model of Water Cooler (3rd Angle Projection)

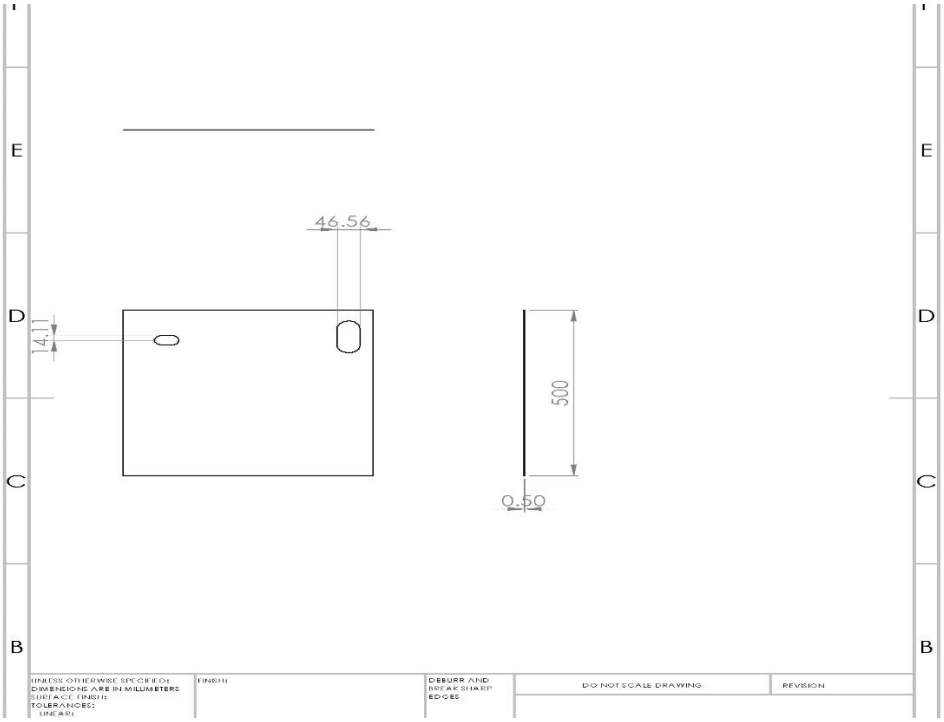
1. Base Draft



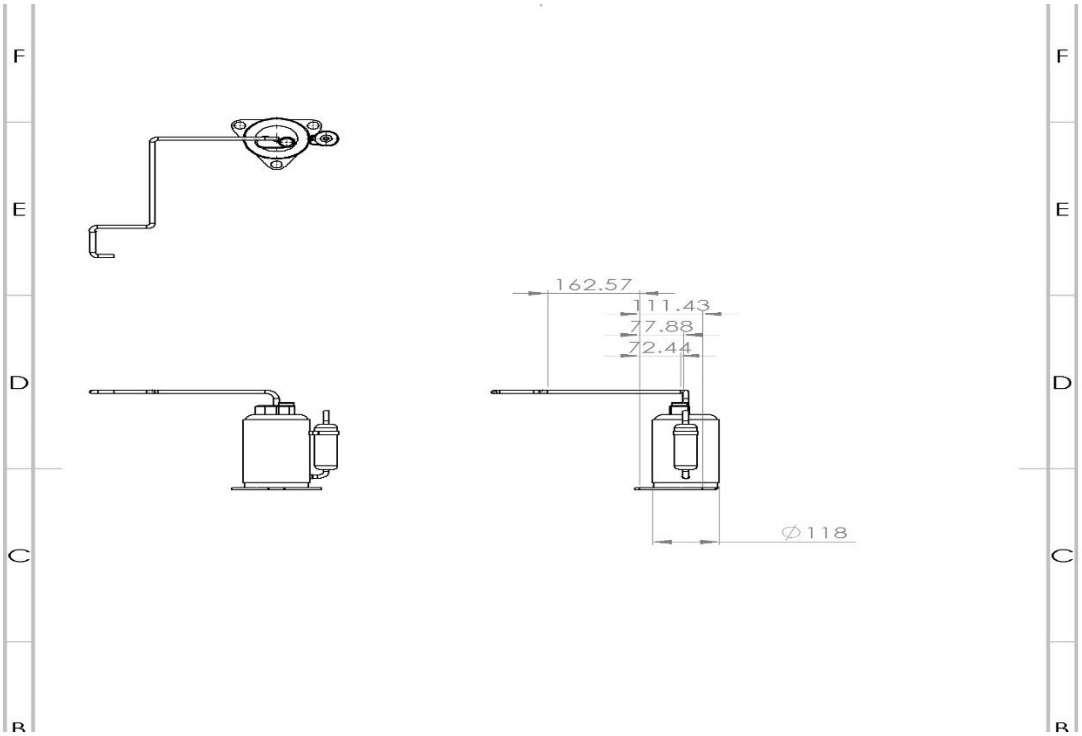
2. Capillary dryer draft



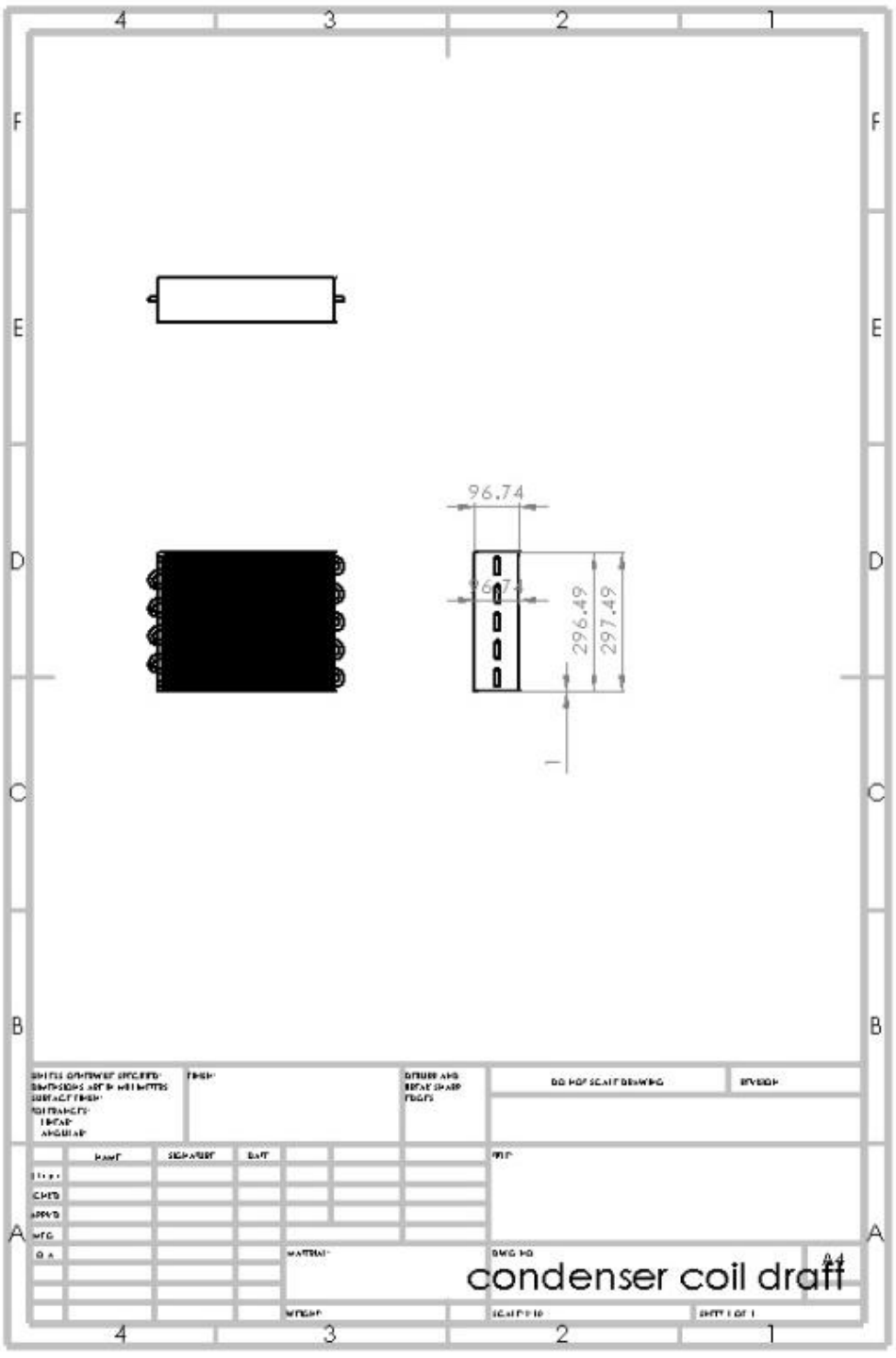
3. Chiller Base Draft



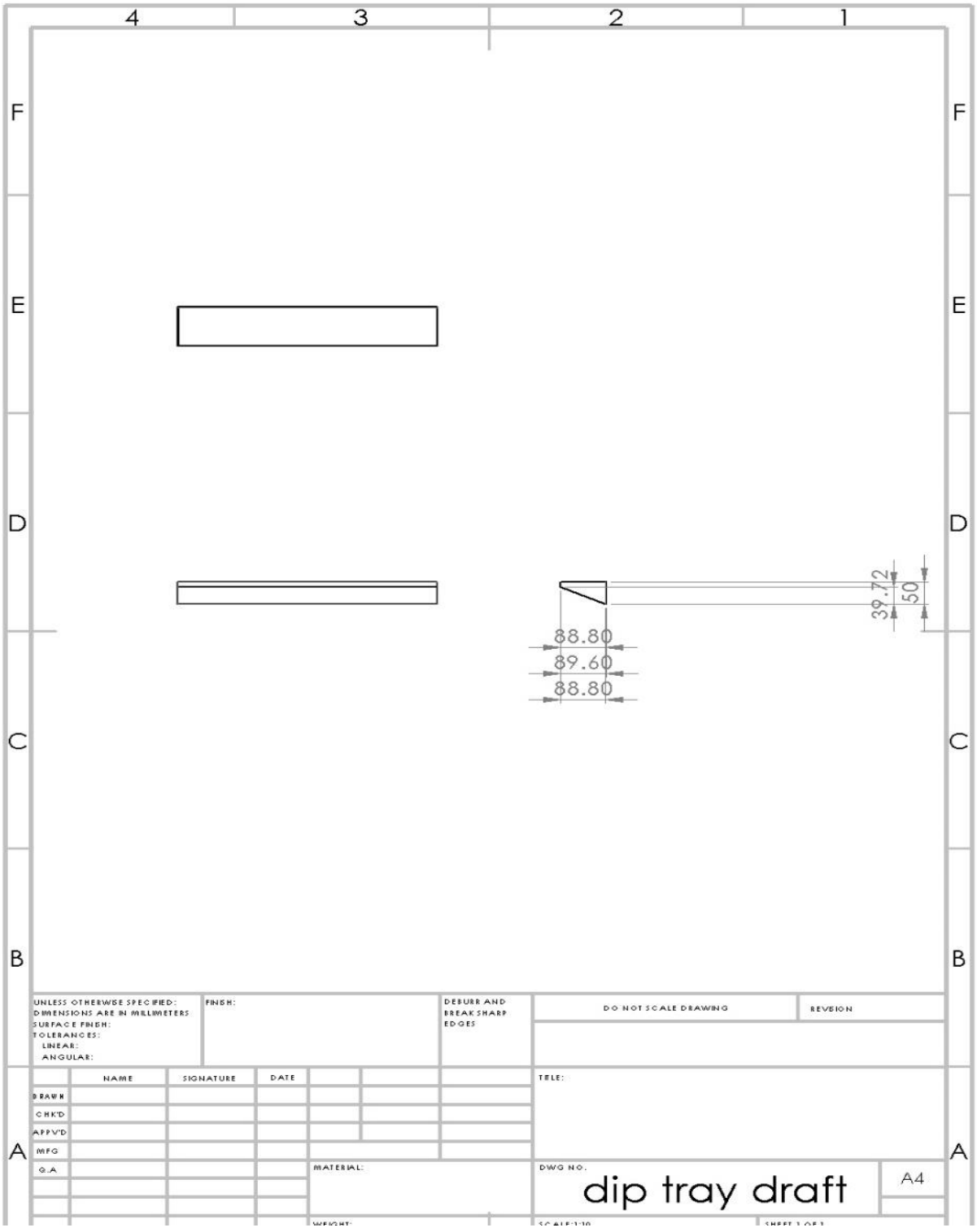
4. Compressor Fin Draft



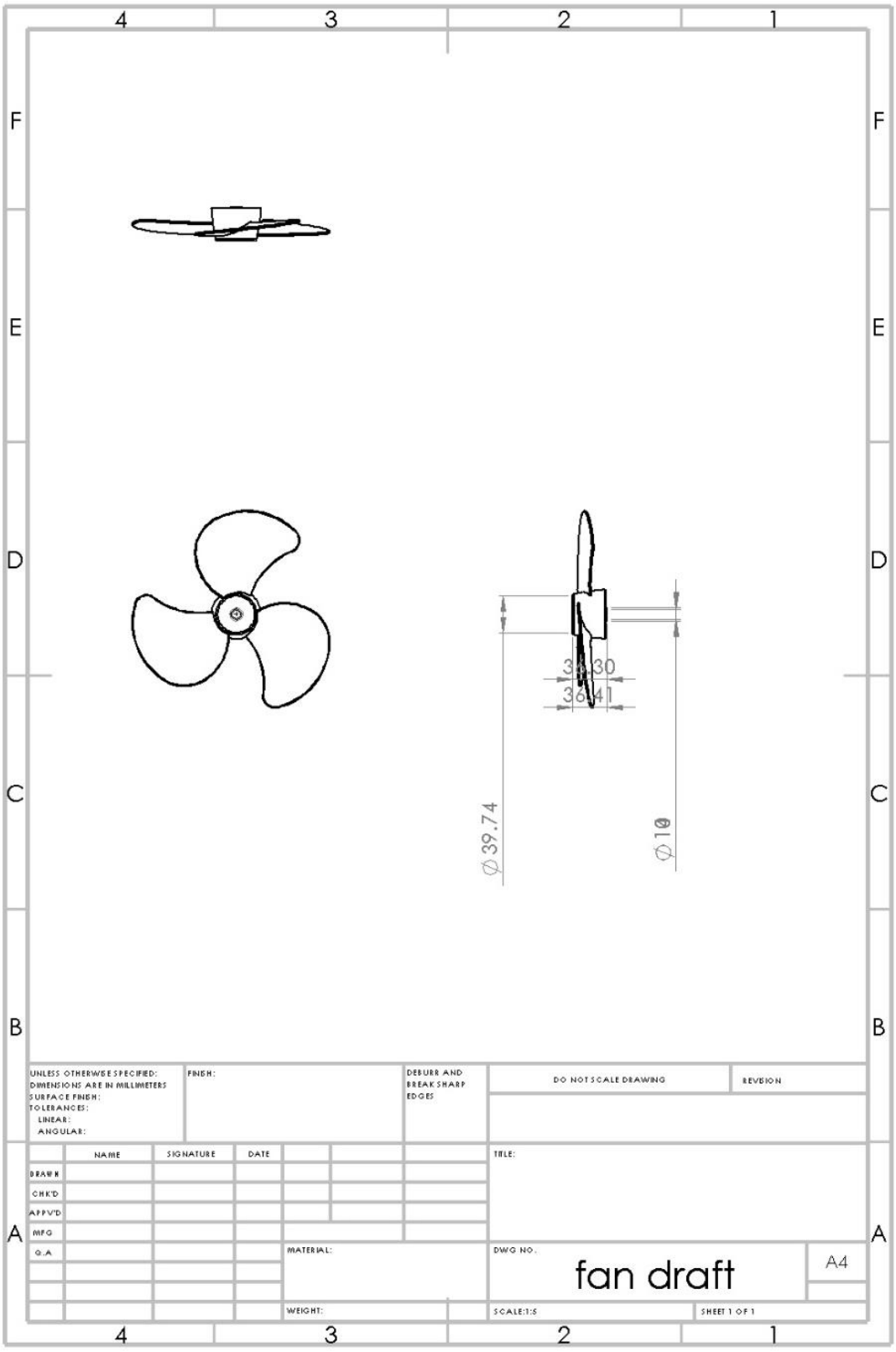
5. Condenser Coil Draft



6. Dip Tray Draft



7. Fan Draft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3
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UNLESS OTHERWISE SPECIFIED:
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fan draft
A4
WEIGHT:
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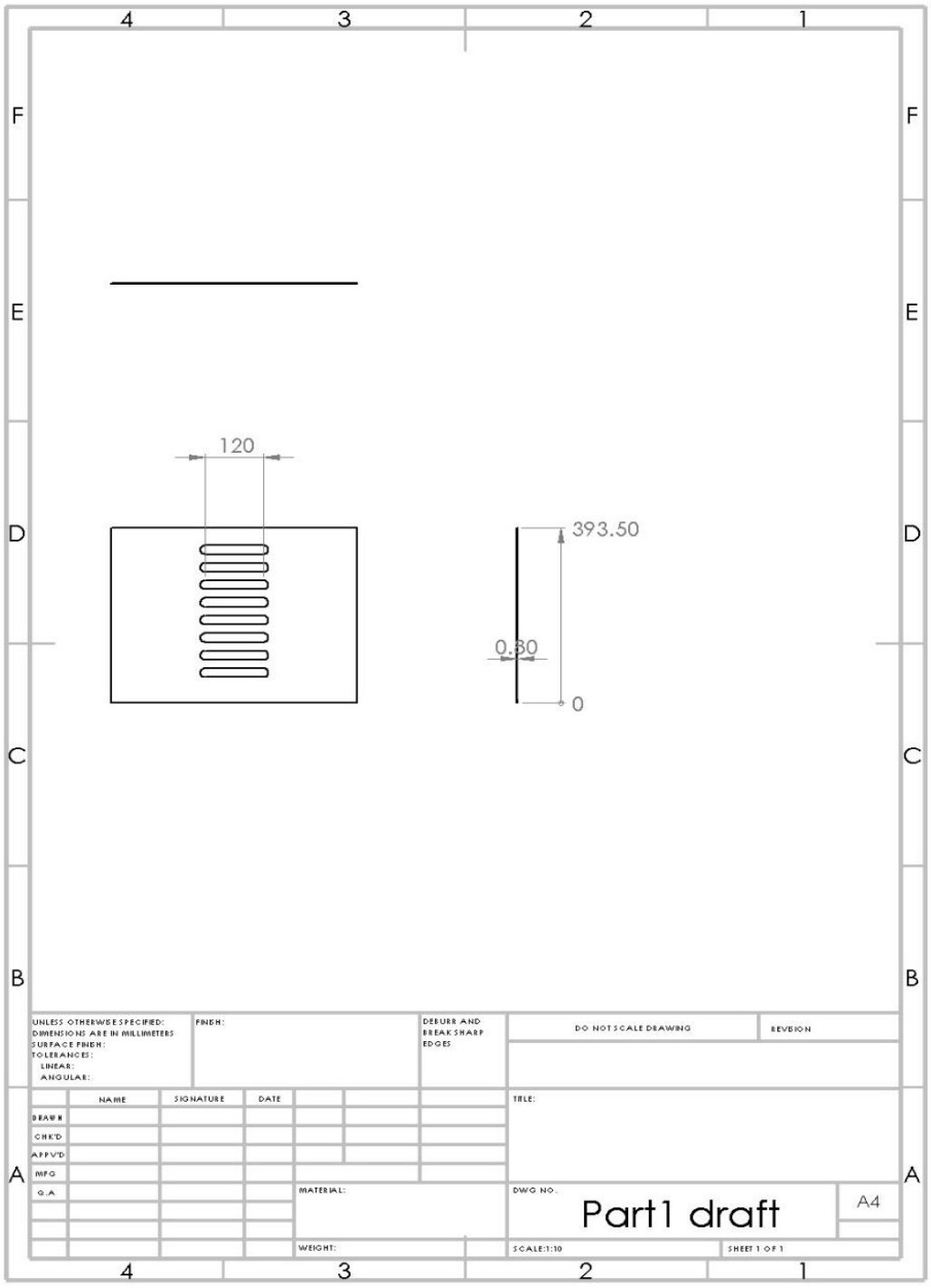
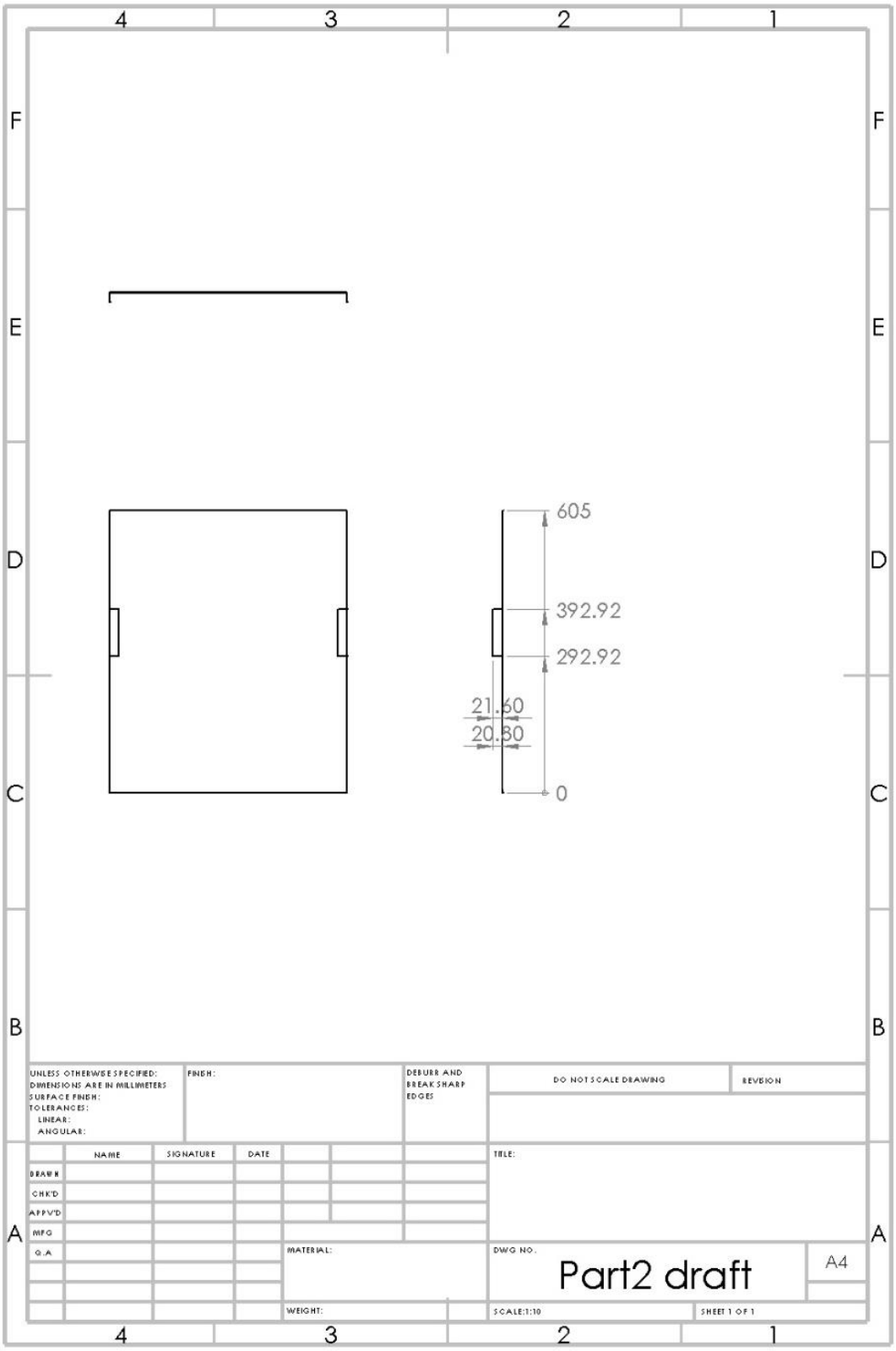
SHEET 1 OF 1

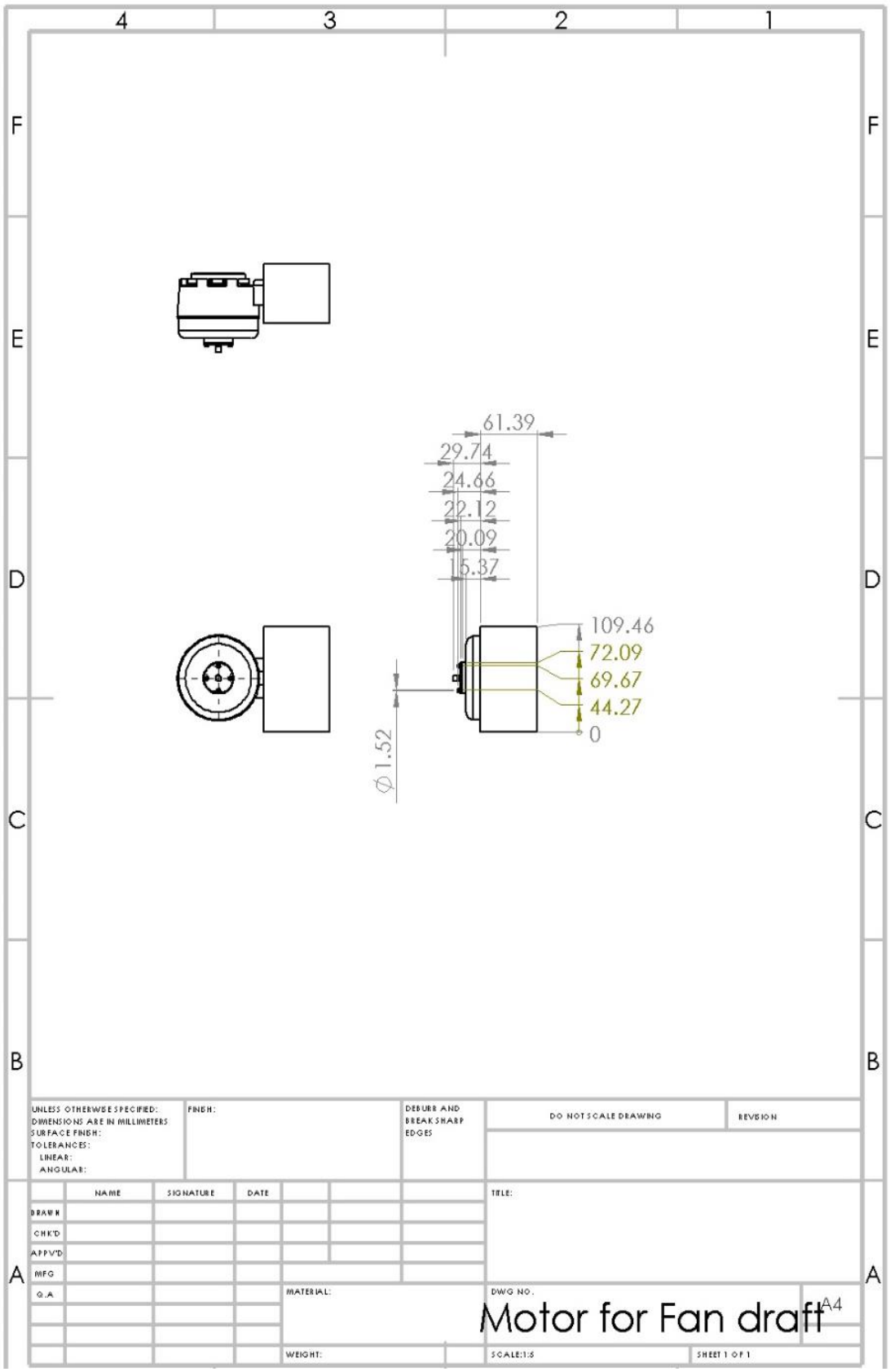
8. Front Bottom and Rear Bottom Draft



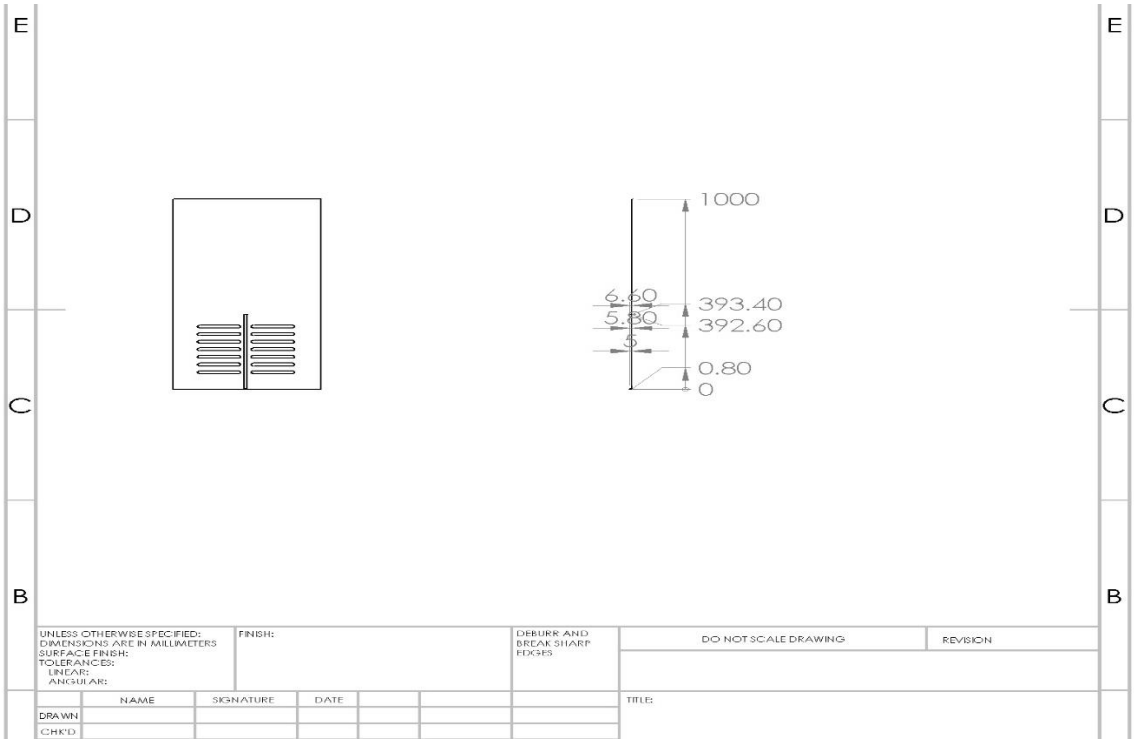
9. Front Top and Rear Top Draft



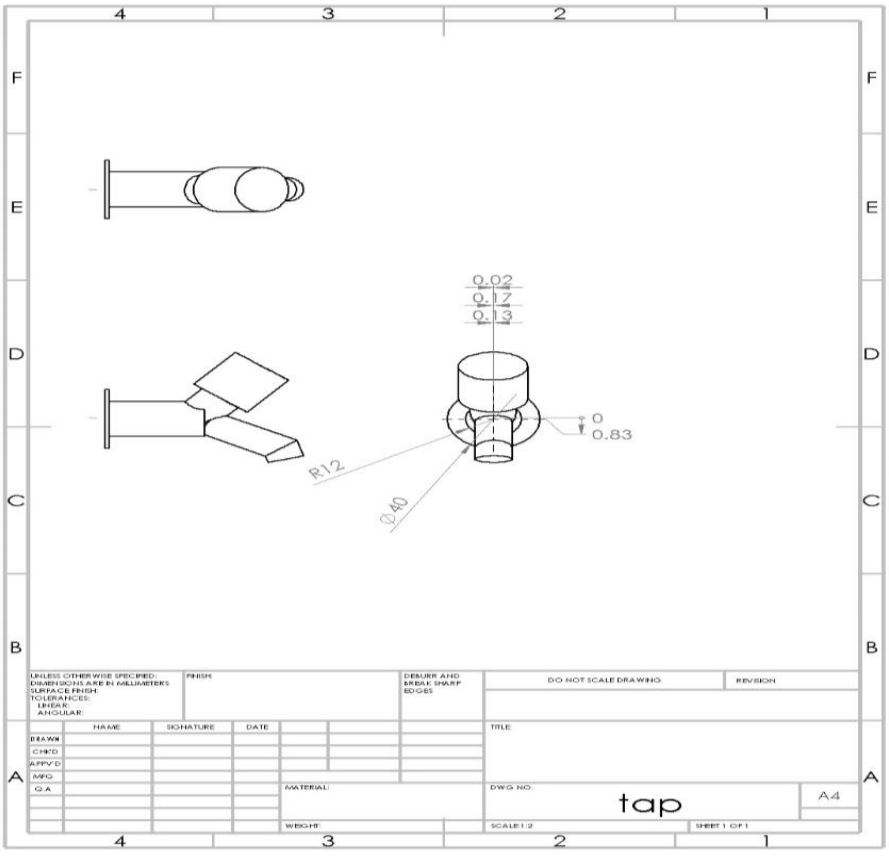
10. Motor for Fan Draft



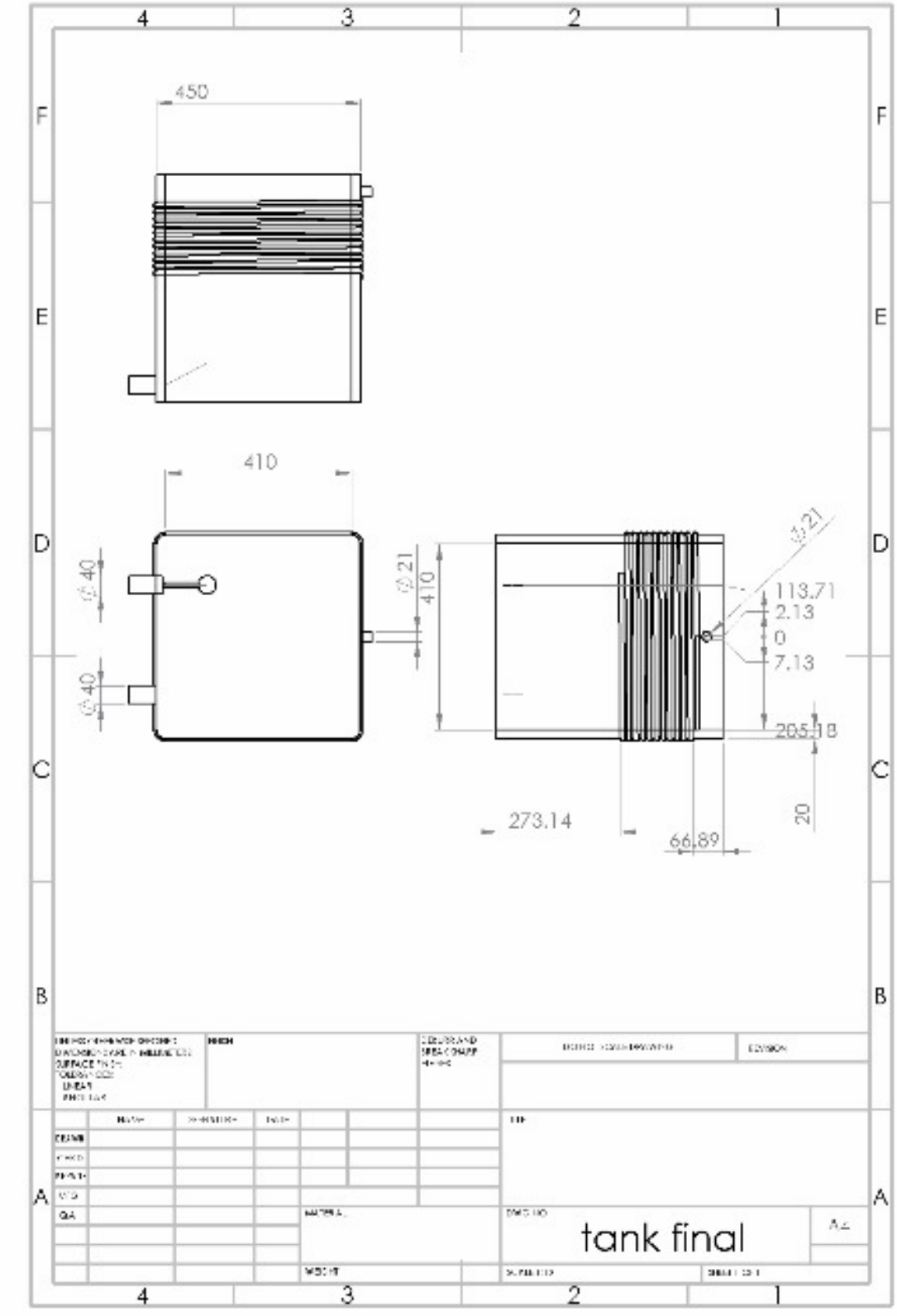
11. Side Panel Draft



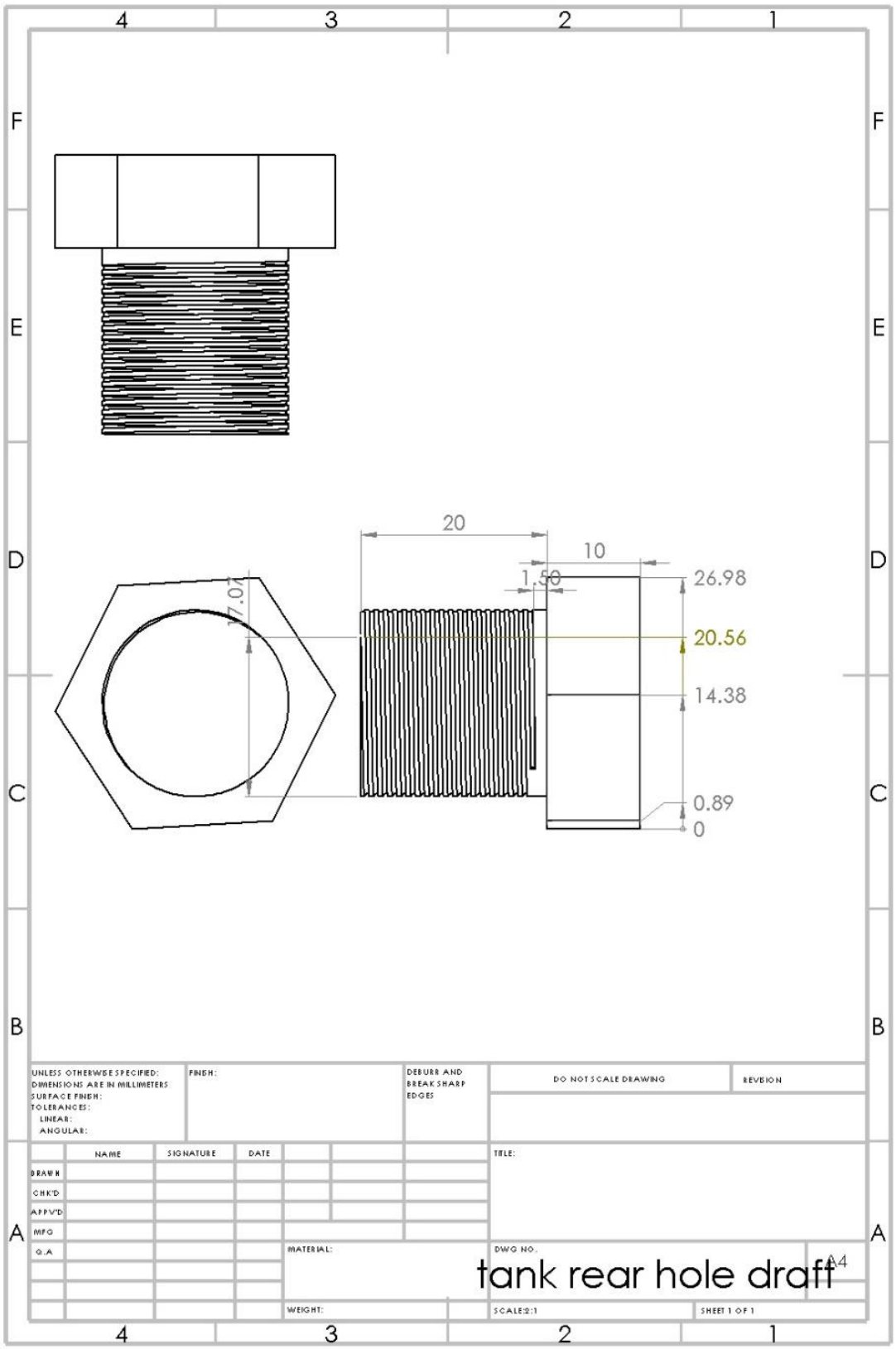
12. Tap Draft



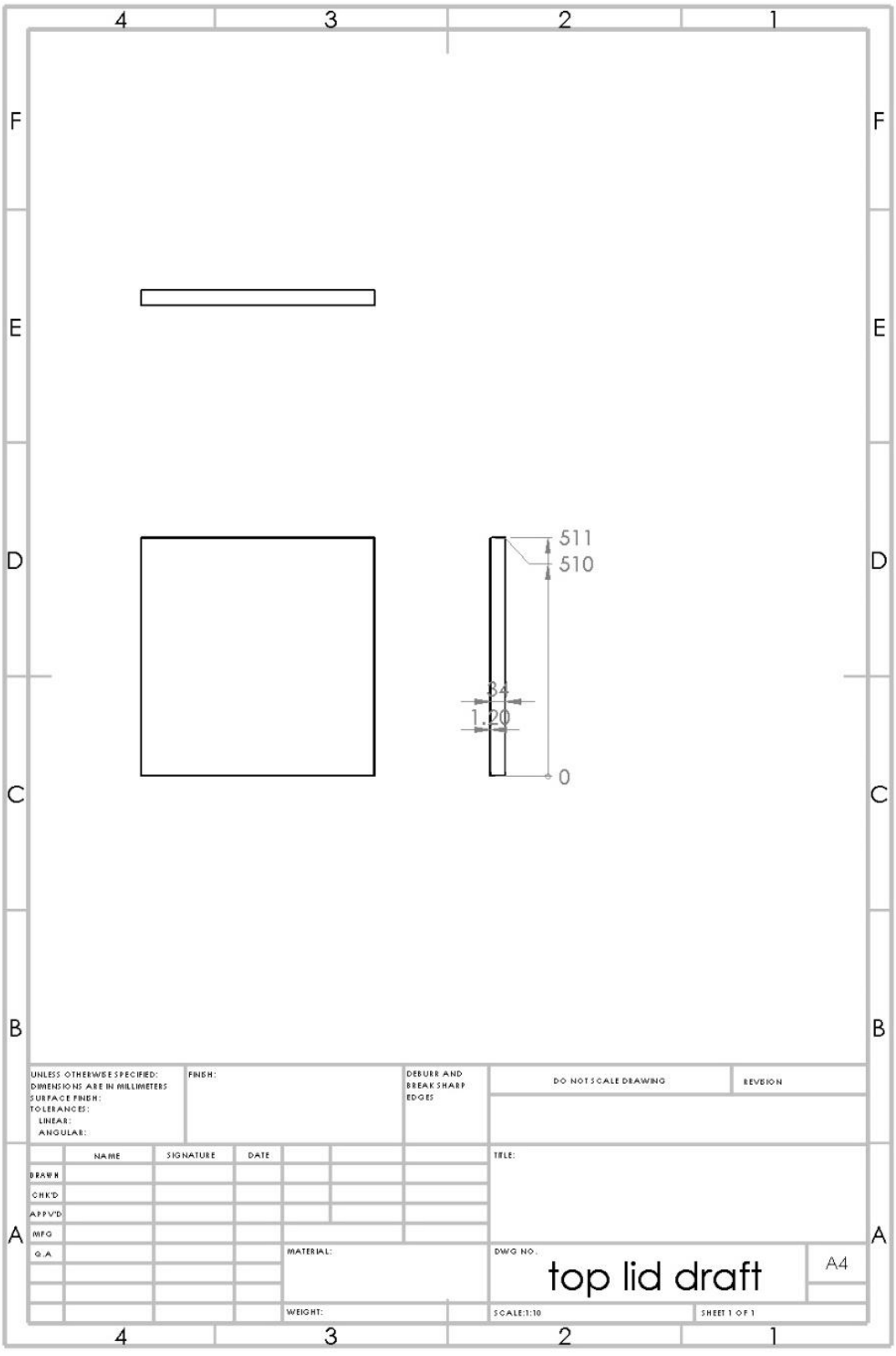
13. Tank draft



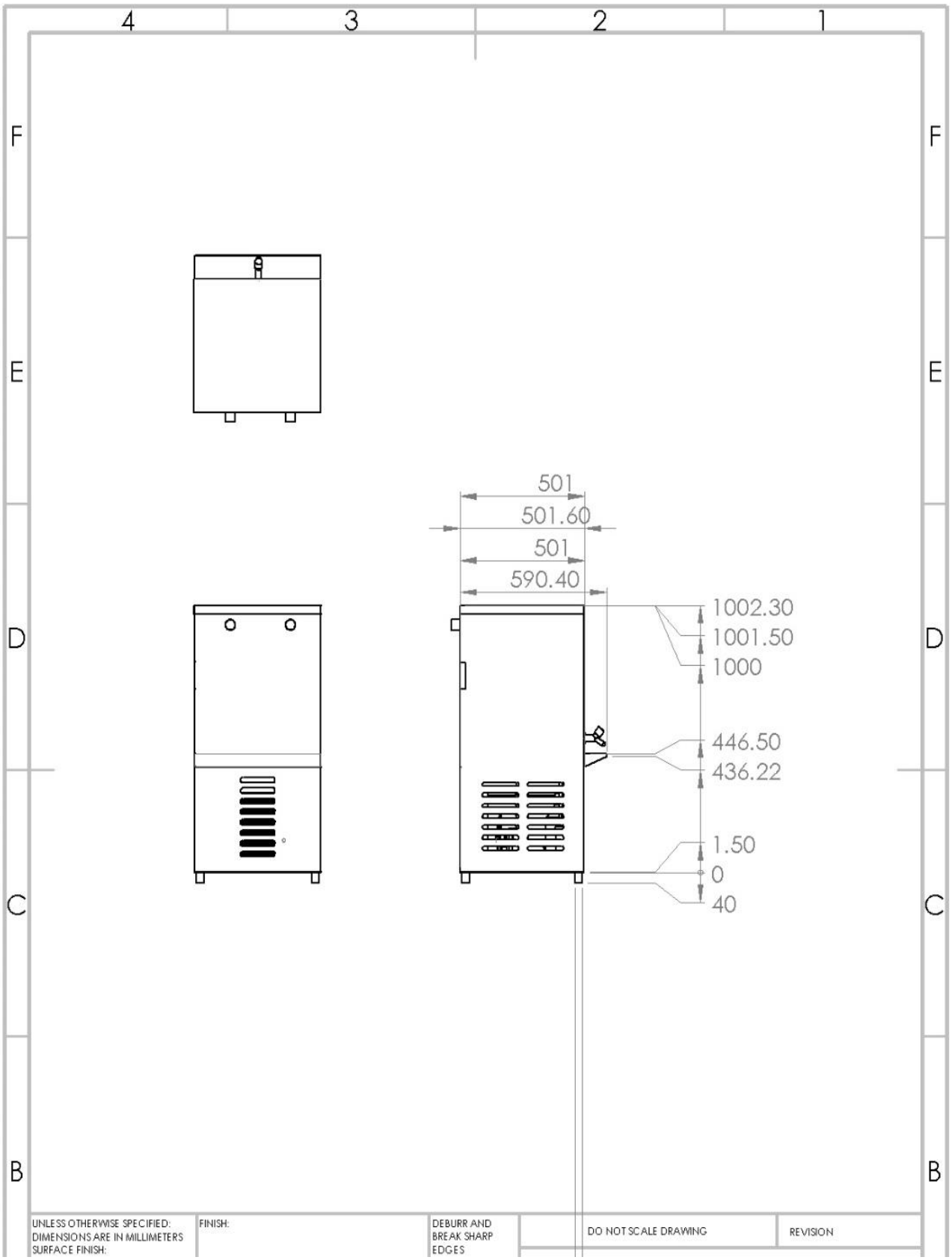
14. Tank Rear Hole Draft



15. Top Lid Draft



16. Final Draft



CNC Code for:

1.Water Tank

G28G91Z0

G28G91X0Y0

M03S1200

G0G53G90X(-5)Y(-5)Z10

G01Z(-0.8)F30

G01Y41.11

X0

G03Y51.11R5

G01X(-5)

X505

X1805

Y51.11

X1800

G03Y41.11R5

G01X1805

Y(-5)

X(-5)

G01Z10

G01X123.32Y463.14

Z(-0.8)

G03X133.32

G03X123.32

G01Z10

G01X893.28Y36.688

Z(-0.8)

G03X903.28

G03X893.28

G01Z10

G01X1666.68Y463.14

Z(-0.8)

G03X1676.68

G03X1666.68

G01Z10

G01Z10

G28G91Z0

G28G91X0Y0

M05

M30

2. Side Panel

```
G28G91Z0

G28G91X0Y0

M03S1200

G0G53G90X0Y0Z10

#500=1

#501=7

#502=[-25.58]

#503=124.74

#504=[-156.06]

#505=115.26

#506=7.74

WHILE[#500LE#501]DO1

{

G01X[#502]Y[#503]

G01Z[-0.8]F30

G01X[#504]

G03Y[#505]R[#506]
```

```
G01X[#502]
G03Y[#503]R[#506]
G01Z10
#503=#503-40
#505=#505-40
#500=#500+1
}
END1
#507=25.58
#508=124.74
#509=156.06
#510=115.26
#511=1
#512=7
WHILE[#511LE#512]DO2
{
G01X[#507]Y[#508]
G01Z[-0.8]F30
```

```
G01X[#509]
G02Y[#510]R[#506]
G01X[#507]
G02Y[#508]R[#506]
G01Z10
#508=#508-40
#510=#510-40
#511=#511+1
}
END2
G28G91Z0
G28G91X0Y0
M05
M30
```

Contribution:

Week 1:

General discussion on our project, ”Water cooler” was carried out with all the team members.

Week 2:

Technical details in the project were discussed which includes parts breakdown and working.

Week 3:

Rough sketch for every component was made after the discussions.

Week 4:

CAD model was started for the first component with appropriate dimensions and components were distributed among the teammates.

Week 5:

CAD model for individual components was completed.

Week 6:

Assembly of components was done. CNC coding and report were started simultaneously.

Week 7:

Presentation, Report and CNC coding were completed. CAD model reached its final stage.

Individual Contribution:

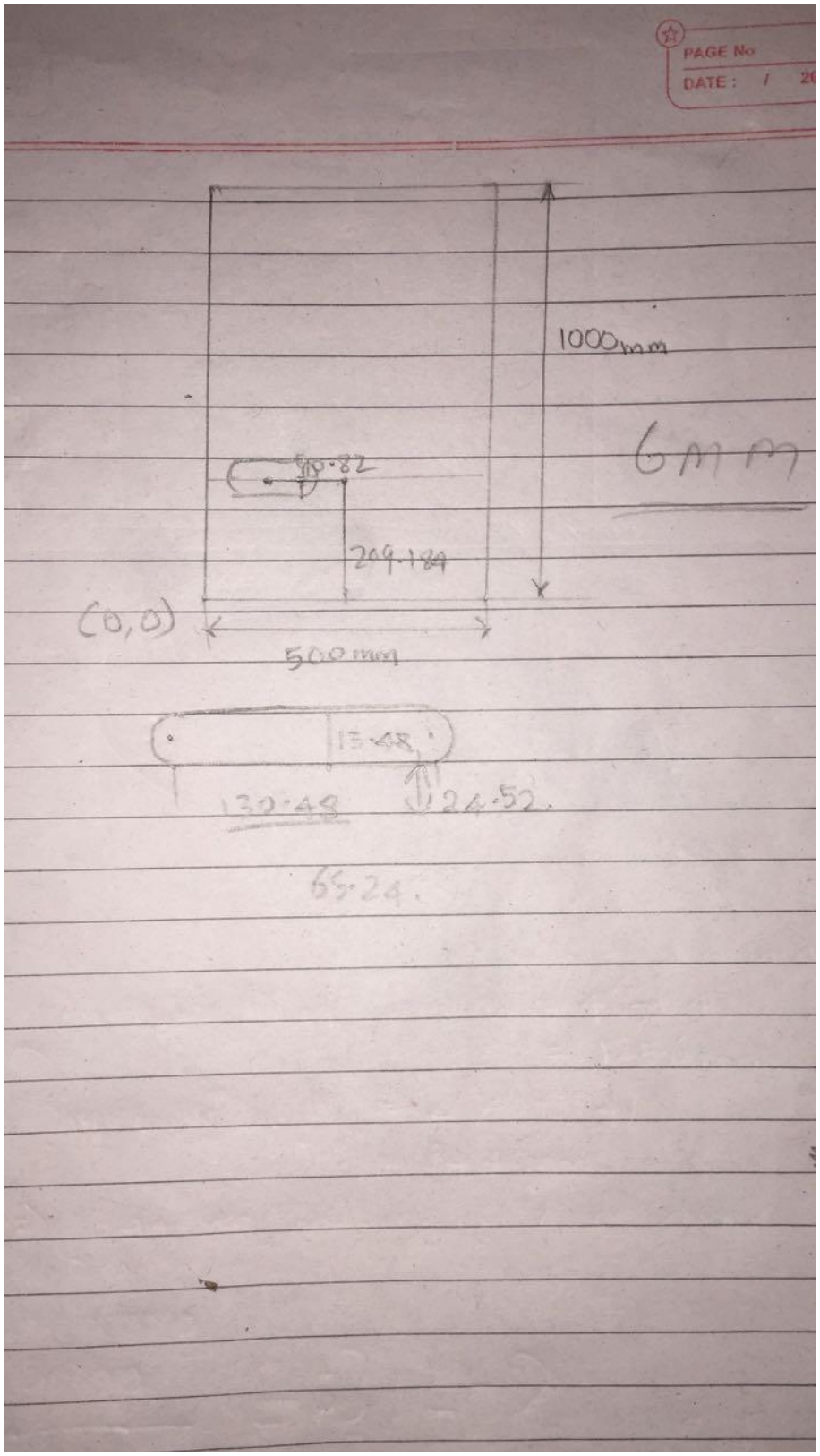
Harikrishnan.A : CAD model

Hasan Fayaz.S.M : Report writing

Mohammed Azharudeen.F : CNC coding and model drafting

Raghav Puri: Presentation and content input

SKETCHES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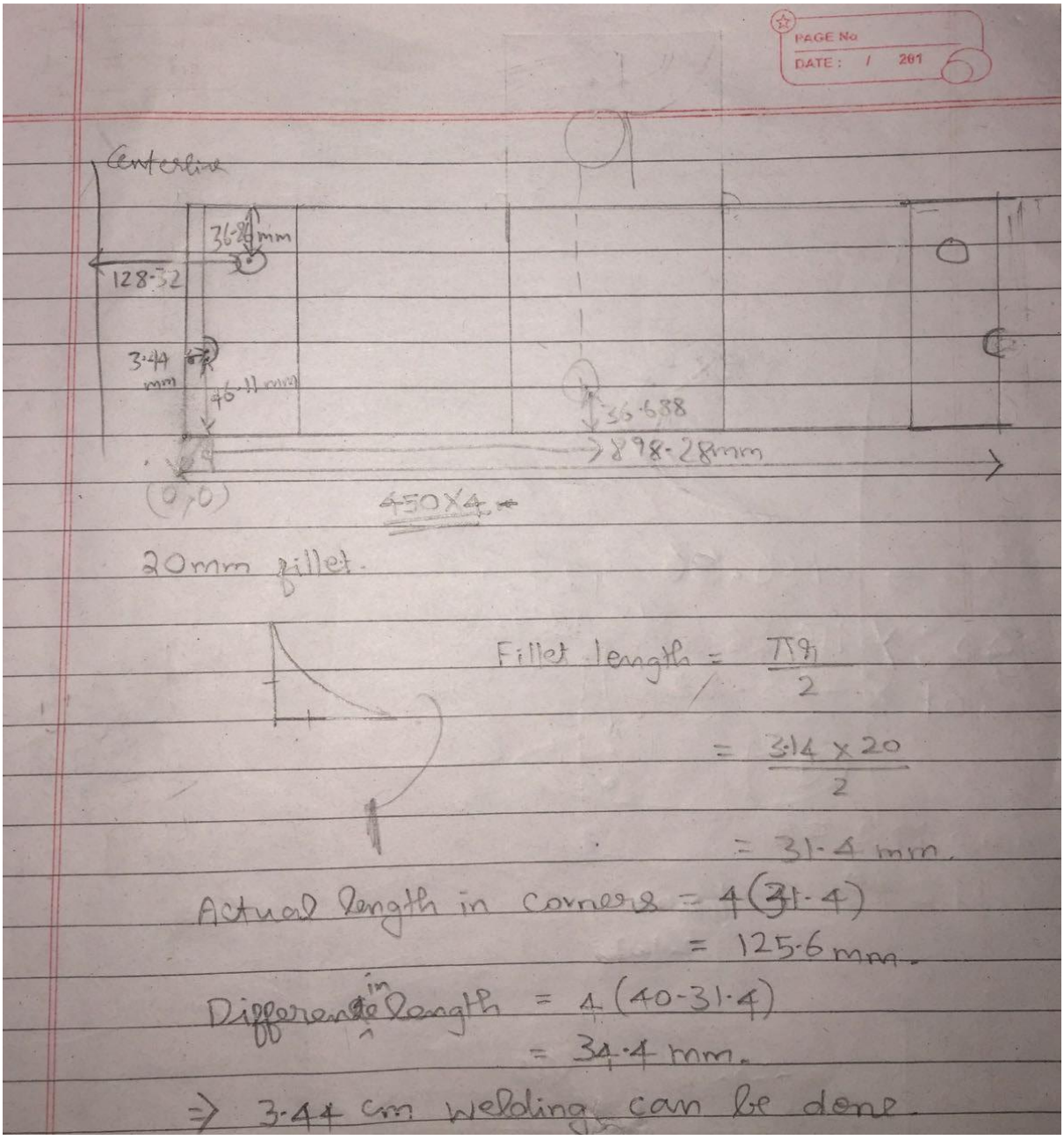
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Centerline
36.28 mm
128.52
3.44 mm
46.11 mm
36.688
898.28mm
(0,0)
450X4 =
20mm fillet.
Fillet length = πr/2
= 3.14 x 20/2
= 31.4 mm.
Actual length in corners = 4(31.4)
= 125.6 mm.
Difference in length = 4(40-31.4)
= 34.4 mm.
⇒ 3.44 cm welding can be done.

THANK YOU.