Mohamed Khider University of Biskra
Faculty of Science and Technology
Department of Mechanical Engineering

MASTER DISSERTATION

Field: Sciences and Technology
Department: Mechanical Engineering

Specialty: Physical metallurgy

Ref.:………….

Theme:

Design and Fabrication of Gadgets for Mohamed Khider Biskra University

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Academic year: 2020- 2021

ACKNOWLEDGEMENT

First of all, I would like to thank Almighty God for giving me all the abilities and courage to do this humble work.

I would like to thank my supervisor, **Dr. Ben Zine Haroune Rachid**, for suggesting, directing, and monitoring this work, and for the assistance that he provided me throughout this work.

My thanks to :

Professor **Boumerzoug Zakaria** and **Dr. Baggar Abdelhakim** for the time and effort that they spent reviewing my work.

I also thank **Mr. Ben Machich Massoud** for his advice, assistance and encouragement, **Mr. Guettala Ismail** and all the staff in the technological lobby

I also express my sincere thanks to **Dr. Guerira Balhi** for the encouragement

I would like also to express my respect to teachers for all their support to me during all these years.

DEDICATIONS

I DEDICATE THIS HUMBLE ACT TO THOSE WHO ENLIGHTENED ME ON THE PATH OF WISDOM AND GAVE ME ALL THAT IS DEAR TO ME AND FILLED MY HEART WITH LIFE WITH IMMENSE GENEROSITY AND TENDER TENDERNESS.

TO YOU, DEAR MOTHER,

TO YOU, MY FATHER.

TO MY BROTHERS AND SISTERS

AND THEIR CHILDREN.

ALL MY FAMILY

ALL MY FRIENDS

(WALID, RAZIKA, WIDAD, MERIEM, ZINEB, SAIDA, KHADIDJA, ADLAN, ALI)

ALL WHO GIVE A CONTRIBUTION TOWARDS THE REALIZATION OF THIS THESIS.

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General Introduction

Biskra University is one of the best Universities in Algeria; it has good collaborations with national and international companies.

The good scientific production is one way to reflect the university reputation, but a simple real product will help also to improve the good image of the university and gives a symbolic impact and a good souvenir for the visitors or graduated students.

Biskra university is equipped with vast verity of manufacturing machines, so why we don't manufacture even the simplest gadgets that the university present in every manifestation?

The objective of this dissertation/ work is to design and elaborate Gadgets (Bag Holder and keys Holders) for Mohamed Khider University

The first chapter of this thesis is divided into three distinct parts; the first is devoted to a bibliographical review on molding, types of molding and their characteristics, the second part on powder metallurgy, powder manufacturing processes, and powder metallurgy development steps. The third part of this chapter is devoted to the technique of electrochemical deposition (electrode position).

In the second chapter we will talk about the design of the mold by Solid works Finally, the resultants and discussion

Chapter I

Bibliography Synthesis

Introduction

This chapter is a bibliographic study of the different process that we may use in our experiment. It is divides into three parts: the first part is describing a bibliographic study on molding, the types of molding (permanent and non-permanent mold). Then we talk about powder metallurgy, these advantages. We will also present the various methods used for the preparation of metal powders as well as the powder shaping techniques. In the end we talk about electroplating, principle of electroplating, and influence of different factors on electroplating.

I .1.Casting

I.1.1.Definition

The term casting defines both the metallurgical installations in which metals are melted and where they are poured into molds to give them the shape of the objects to be manufactured, as well as all the operations necessary for their production [1].

It is, at the same time, an art and a profession whose origins go back several millennia before our era, using and implementing techniques as diverse as they are varied, such as molding, coring, metallurgy, melting and casting of metals and metal alloys, heat treatments, finishing,…etc [1].

The casting is also an industry producing parts of all kinds, in all quantities, in the most economical way from raw materials (scrap metal, hedgerows), unlike certain competing techniques (forging, mechanical welding ...) using semi-finished products such as sheet metal, steel bars and billets of all types, produced by the steel industry [1].

The casting has been able to constantly improve its performance thanks to progress in all its technical components, both in precision and reliability, allowing it to compete with, or even replace, parts usually manufactured by other techniques (forging for example). All these developments and all these advantages explain the very wide distribution of casting parts in all branches of industry and the capacity for progress of this technique suggests wider applications in the future [1].

In the casting specialization, the following types are practically distinguished

A) According to the nature of the metals and alloys: [2]

- Cast iron casting.
- Steel.
- casting of aluminum and its alloys.
- casting of copper, bronzes, brasses etc...

B) According to use: [2]

- Art casting.
- Ornamental casting (jewelry).
- Casting of industrial mechanics.

C) According to the molding process: [2]

- Sand casting (manual or mechanical).
- Shell molding.
- Lost wax casting.
- Shell molding (permanent mold).

I.1.2.Definition of molding

The molding process is the manufacturing process in which molten material such as metal is poured into the casting cavity or mold of the desired shape and allowed to harden or solidify within the mold, after solidification the casting is taken out by ejecting or by breaking the mold [3].

I.1.3.The mold:

A mold is the set of suitable elements, delimiting the imprint, and receiving the liquid metal that after solidification will give the room. A mold consists of one or more parts that canbe separated from one another (frames, screeds, shells) [4].

The surface common to the two half molds is called the joint plane even if this surface does not form a plane. A distinction is made between two types of mussels, namely non-permanent mussels and permanent mussels [4].

I.1.4.Types of casting:

Permanent mold casting	Non-permanent mold casting
Shell molding	Sand casting
Die casting	Molding with model
Centrifugal molding	Molding with model plate
Continuous casting molding	Molding without model
Low pressure die casting	Lost wax casting

Table. I.1. The different types of molding.

I.1.4.1.Non-permanent mold casting:

Expendable mold casting refers to any casting process in which the mold cannot be reused. Casting molds are designed to hold molten metal, so they naturally experience a significant amount of stress (figure. I.1). Iron, for instance, has a melting point of 2,800 degrees Fahrenheit. When poured into a mold cavity, the fiery-hot iron may damage or deform the cavity's interior. Regardless of the type of metal used, though, all expendable mold casting processes are characterized by their non-reusable mold [5].

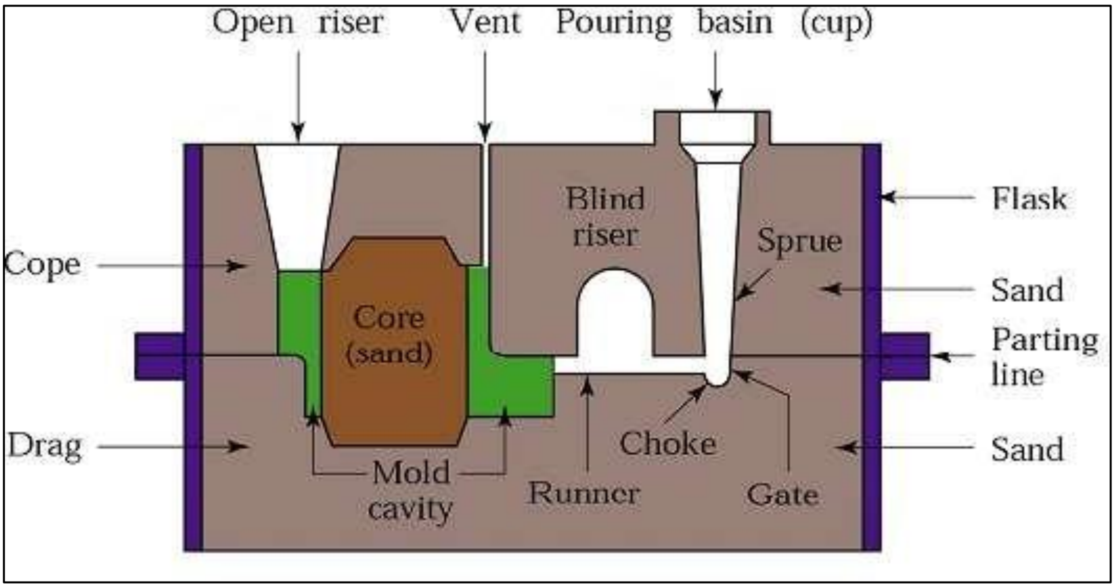

Figure. I.1: Sand casting process [3].

I.1.4.2.The permanent mold

Casting in permanent molds (metal, cast iron or steel) makes it possible to produce a large number of parts with a single metal mold, capable of withstanding cyclical thermal shocks, erosion and chemical attack (partial dissolution or tinning) resulting from contact with liquid aluminum, without deforming. The mold must have good mechanical strength and its maintenance closed during casting (which can be done either by gravity or under pressure) must be ensured by the bench or the casting machine. In general, these metal mold casting processes are superior to sand casting with regard to the following points: fineness of the metallurgical structure; static and dynamic mechanical characteristics via the cooling rate, except in conventional pressure casting where the turbulence of the filling considerably degrades the compactness and the content of inclusions; dimensional accuracy, surface condition (function of coating). These processes require very well studied part layouts and good quality molds. They require great rigor in implementation and require the monitoring of certain parameters such as the regularity of the production cycles, the temperatures of the mold and of the cast metal. Al-Si alloys are by far the best suited to these processes. Alloys sensitive to hot cracking [6].

I.1.4.2.1.Shell molding:

This is a very common process in aluminum melting. Its main advantages are:

- Possibility of manufacturing large series with a high degree of mechanization.

-Possibility of manufacturing in medium and small series with modest investments.

-Reliability and low dispersion of the results provided that control and control of the parameters are ensured.

-Excellent mechanical properties and possibility of heat treatments.

The mold can be made, depending on the constraints, in different materials: gray cast iron, GS cast iron (spheroidal graphite cast iron), steels of various grades, including alloys. The different parts of the mold can be either machined in the mass or produced by molding. The (figureI.2. represents the shell molding model) [7].

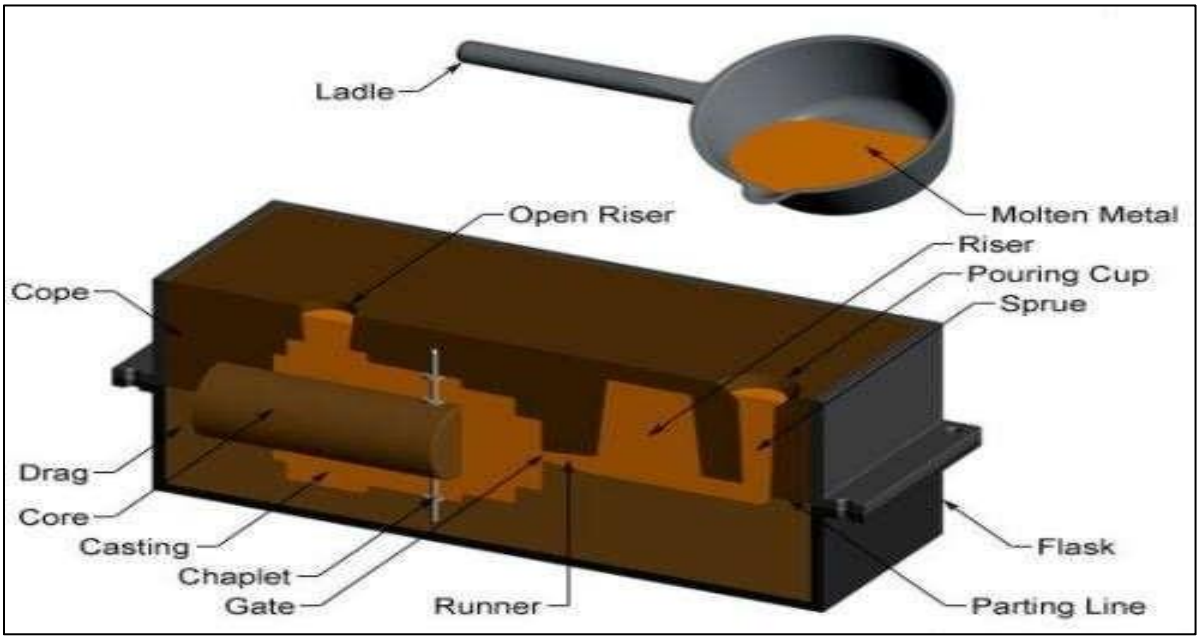

Figure.I.2. Shell molding process [3].

- **Principle of shell molding :**

Shell casting is a casting process using a metal mold and gravity casting. This is the process that is generally used for large series. It is rather reserved for light alloys with low melting points (aluminum alloys, zinc ...) because the casting in the molds of parts whose melting temperature is too high causes rapid degradation of the elements of the mold [8].

As shown in figure (II.3) the process breaks down as follows. The mold dies (a), previously machined, molded or obtained by Electro Erosion by Sinking, are prepared for the casting of the metal by heating (application of a coating on the impression in order to avoid sticking of the parts) then assembled (b). The setting and maintaining in position are generally provided by pneumatic actuators. The casting is then carried out (c). The conductivity and heat capacity of the metal being high, the cooling rate of the alloy in the mold is very high. Solidification therefore takes place very quickly and the matrices are separated (d). The part with the remainders of the filling and feeding system then forms a cluster (e) which will have to be extracted and then trimmed (f). The cycle then resumes [8].

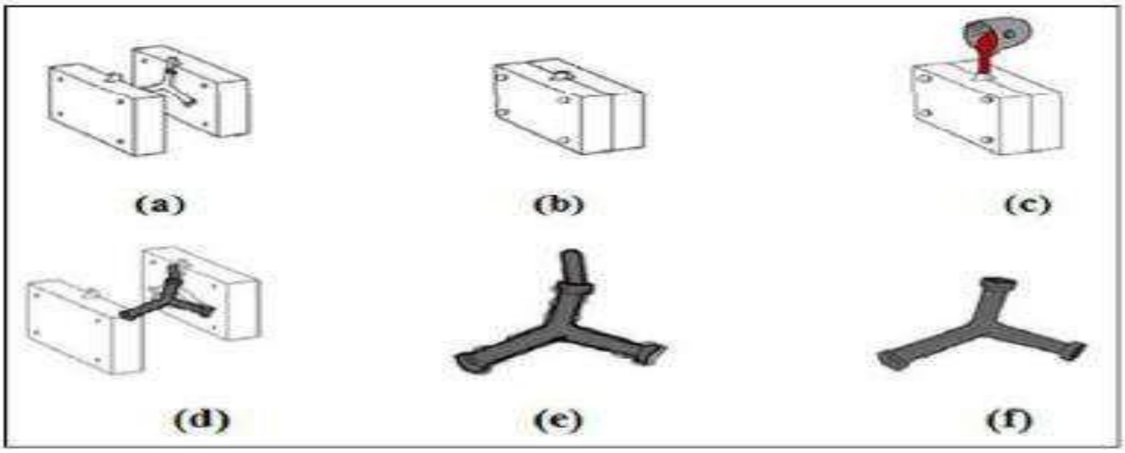

Figure. I. 03. Main steps of the shell molding process (a): mold dies, (b): assembly, (c) making the casting, (d):separating the dies, (e): cluster former (f): extracting then debarring [8].

Exemple of gravity molded parts:

In the figure (I.4) below are examples of some of the parts made by gravity shell molding

Figure.I.4.Gravity molded parts [8].

I.1.4.2.2.Injecting molding

In this process (figure.I.5), the liquid metal is injected into the mold of the die-casting machine (30 to 100 MPA). This process makes it possible to obtain parts having a very complicated configuration with very precise dimensions, which makes it possible to partially eliminate 42 or totally the machining operation. Due to the very high costs of the molds, die casting is profitable only for mass production. So die-casting machines allow very large series to be produced and with extremely fast production rates (1000 low volume parts / hour) and are intended above all for alloys such as Lead, Zinc, Aluminum, Magnesium, Copper, etc [2].

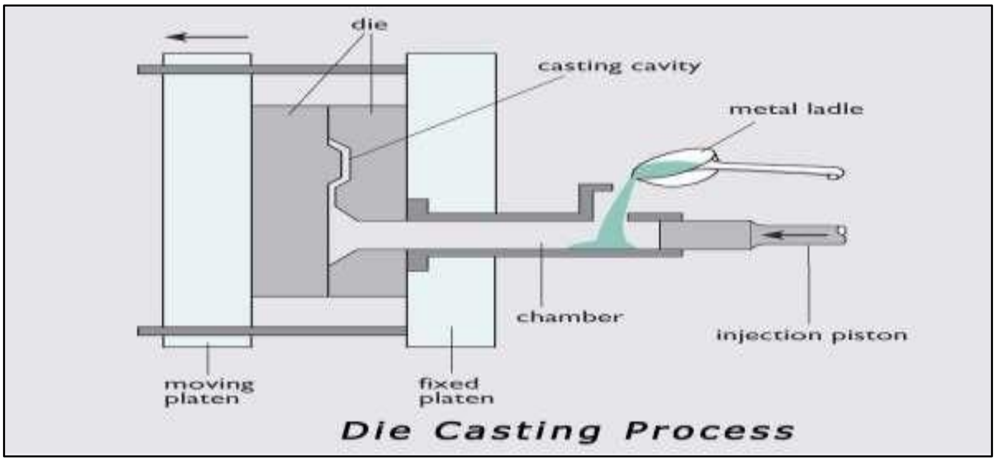

Figure .I.5.Injection molding process [9].

I.1.4.2.3.Centrifugal molding

Centrifugal casting can produce excellent parts that do not have the defects and porosity often seen with other methods of casting (shown in figure.I.6). This casting method works by depositing molten metal in to the center of a mold which spins continuously. The molten metal is pushed to the circumference by centrifugal force and solidifies there from the outside in. Because the part solidifies in one direction while under pressure, porosity is eliminated almost entirely. Because new molten metal is added continuously to the inner diameter, any shrinkage is filled naturally. In addition, any defects that are less dense than the metal collect at the inner diameter and can be machined off for superior purity [10].

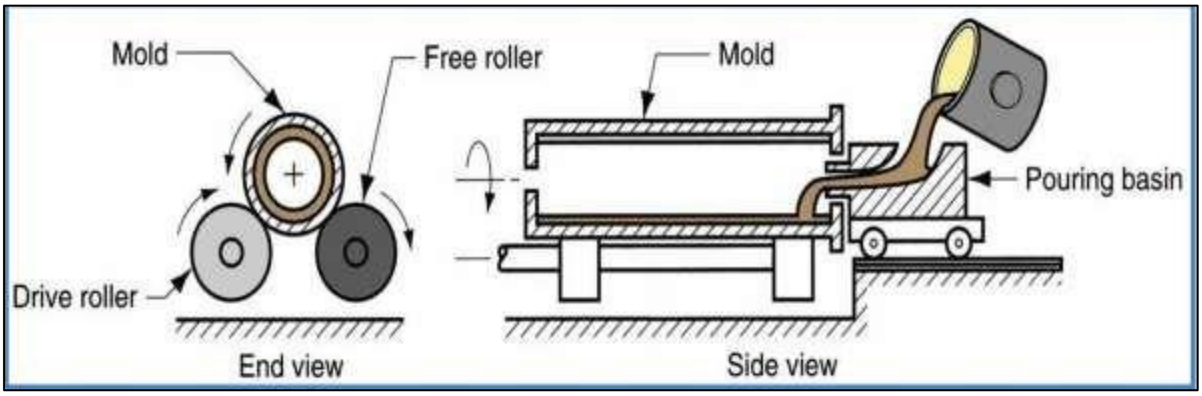

Figure.I.6. Centrifugal molding process.

I.1.4.2.4.Continuous casting molding

Continuous cast shapes are produced by introducing molten metal into a vertical or horizontal mold that has the ability for rapidly chilling the metal to the point of solidification. The rapid chilling in the mold ensures a fine, uniform grain structure in the solidified metal

with higher physical properties than sand castings. Once solidified, the cast shaped bar is cutto the desired length [11].

The most common shapes produced are tubes and solids, but square, rectangular, hexagonal, and many other irregular shapes can also be produced to match a desired finished part profile [11].

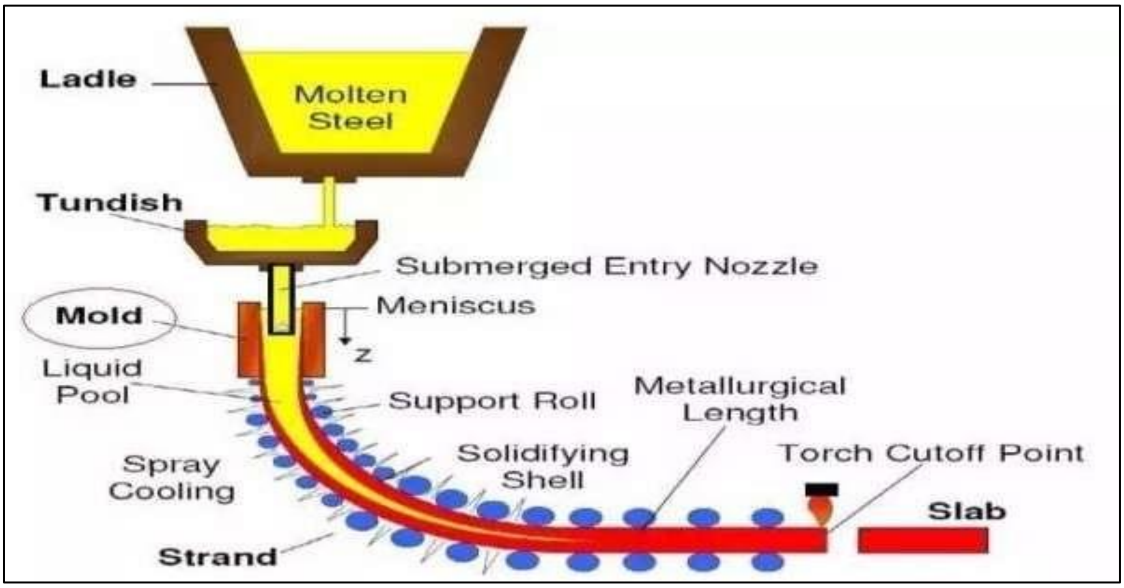

Figure . I. 7. Continuous casting molding process [9].

I.1.4.2.5.Low pressures die casting

Low-pressure casting is used to produce aluminum alloy castings and magnesium alloy castings which require high quality. Low-pressure casting is an advanced casting production technology.

With the development of machinery industry, low-pressure casting has also obtained the very big development in casting production at home and abroad. The emergence of some new technologies and new processes improve the quality of low-pressure casting products, achieving a high rate of finished products. Low- pressure casting is a casting method between pressure casting and gravity casting, with the advantages of smooth liquid mold filling, compact casting structure, high process yield, and of being easy to realize automation, especially suitable for complex, thin-walled castings. Its application in the modern industry is very extensive [12].

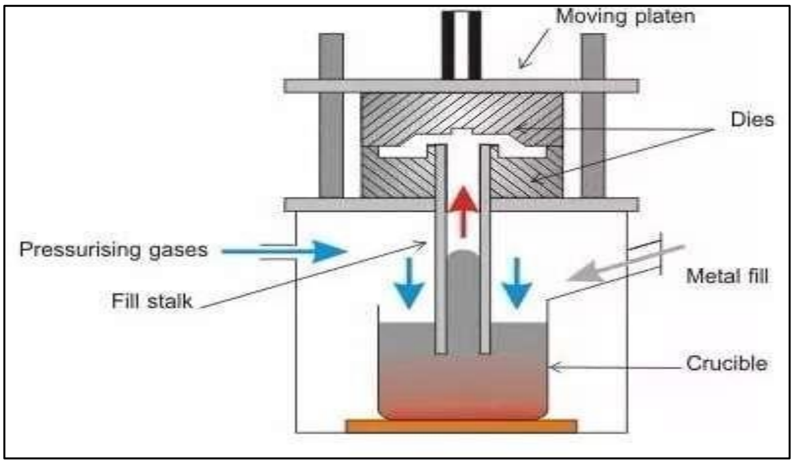

Figure .I. 08. Low pressure dies casting process [9].

I.2.Powder metallurgy

I.2.1.Definition

Unlike conventional metallurgy processes, which always involve the solidification of a molten metal, powder metallurgy starts with a metal powder and uses a consolidation process by reaction between particles of a mass of powder which results in the formation of a continuous and coherent solid [13].

Powder metallurgy (PM) is a set of technological processes allowing the production of components of predetermined shapes from powders (metallic, ceramic or composite) whose particle size and constitution are mastered. This method allows the production of precision parts difficult to obtain by other methods without incurring loss of materials [13].

- Preparation of the powder.
- Densification and shaping.
- Sintering.
- Calibration.
- Heat treatments.
- Finishes.

I.2.2.Process and operation for making powder metallurgy parts

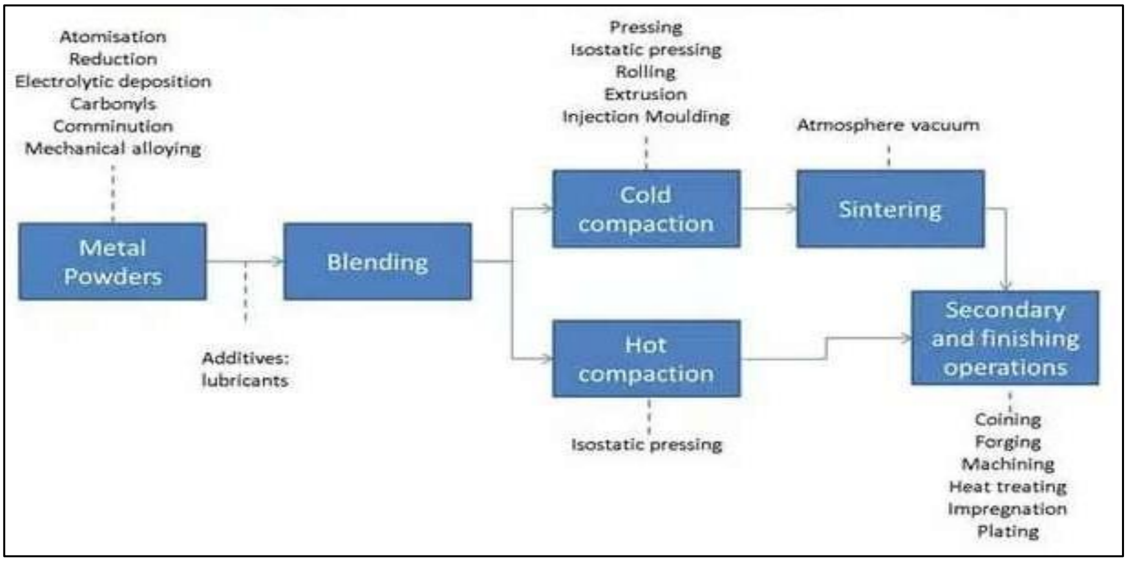

Figure. I.9. outline of process and operation involved in making powder metallurgy parts [14].

I.2.3.The advantages of powder metallurgy

The advantages of manufacturing parts by the powder metallurgy process are numerous. The other advantages of the process are described below [15].

- Reduction of losses of raw materials.
- Reduction or elimination of machining.
- Precise control of composition and physical and mechanical properties.
- Precise control of dimensions and surface finish.
- Manufacture of complex parts.
- Possibility of combining materials that cannot be combined by other methods.
- Possibility of replacing assemblies of several parts by a single part.

I.2.4.The disadvantages of powder metallurgy

There are of course some limitations associated with the process. Among these, let us point out certain constraints regarding the shape and geometry of the parts. It is not possible, for example, to make threaded holes, springs or parts with transverse holes using the powder metallurgy process. In addition, in the case of some parts with complex geometry, it is sometimes difficult to obtain a density that is evenly distributed throughout the part. This nonuniformity of the density distribution can lead to problems of final shapes and weaknesses in

certain parts of the part, [15]. Finally, it should be noted that the maximum size of the parts that can be made by powder metallurgy is directly related to the maximum pressure that the presses are able to apply.

I.2.5.Process for the production of metal powders

The powder can be defined as a set of particles whose dimensions are usually less than 1mm. For the preparation of metal powders, several techniques are used, mainly three categories are cited. Mechanical, chemical and atomization processes [16].

In what follows, we try to give an overview on the methods of manufacturing powders.

I.2.5.1.Mechanical processes

Mechanical methods consist of grinding a metal by an appropriate means; these techniques are based on shock, attrition, shear and compression.

- **Grinding**

The grinding operation is the synthesis of several phenomena such as fracturing, deformation and cold welding [17]. For fragile materials, the first phenomenon takes precedence with a little deformation, while for ductile materials the three phenomena are present. The particles obtained depend on the physical and chemical properties of the material, on the medium in which the grinding is carried out (vacuum, gas, liquid) and on the operating conditions of grinding (quantity and size of the balls, devices used). The devices used are essentially grinders (Figure. I. 10) with jaws, hammers, balls, etc. They are widely used for fragile metals (pure elements such as Mn, Sb, Bi Cr, etc. r Fe-Al alloy, Ni- Al, and Fe-Si…).

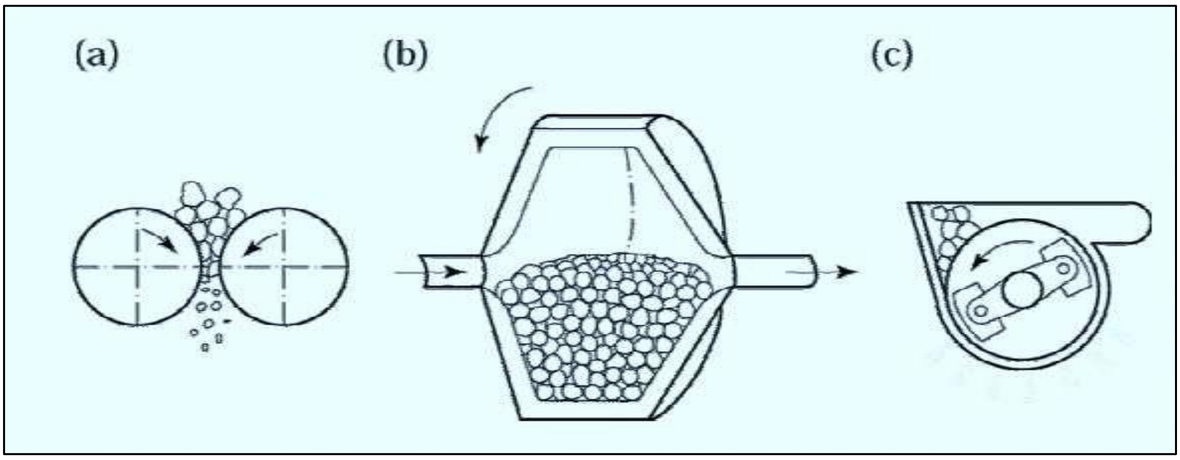

Figure.I.10.The mills (a) ball mill b) SPEX agitator (c) planetary mill [17].

I.2.5.2.Chemical processes

There are different chemical methods used for the production of powders. Due to their diversity and flexibility, they make it possible to produce powders of any element or compound, with average grain sizes that can vary from a few tenths to several tens of µm [18].

- **The reduction**

Is the most widely used chemical production method. It consists of the reduction of a compound (an oxide or a chloride), ground into a fine powder, by a chemical agent (liquid or solid gas) which splits the compound into metal in the form of fine granules and into a sub - product which can be removed. If the initial compound is a solid, the size of the granules of the resulting metal will strongly depend on the morphology of the starting compound [19].

- **Electrolysis**

The production of the powder by electrolysis is a reduction in which a metal ion contained in a liquid solution of the salt or in a molten salt (igneous electrolysis) of the desired metal, is neutralized by the cathode current. The very porous cathodic deposit is then scraped, crushed, washed, and dried [19]. The different stages of the manufacture of the powder by electrolysis are presented below. Figure (I.11).

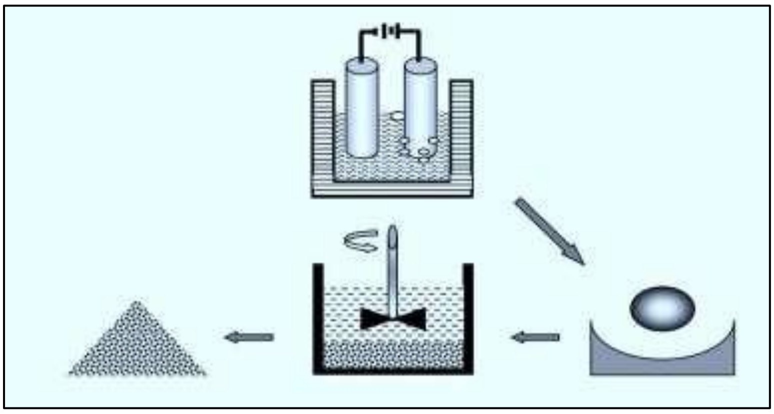

Figure I.11.The different stages of the production of powder by electrolysis [19].

I.2.5.3.Atomization

Atomization is a physical process where the raw material is melted under a neutral atmosphere to prevent oxidation. The liquid passes through a conduit leading it into an enclosure where it is sprayed with a jet of gas or water to obtain fine droplets. These cool and crystallize in flight to fall to the bottom of the enclosure. Currently more 80% of pure or alloyed metal powders (iron, aluminum or titanium alloy, bronzes, steels, etc.) sold are produced by atomization. This success is due to the high productivity of atomization techniques, thus allowing appreciable savings. In addition, atomization is a prerequisite for the manufacture of pre-alloyed powders .The figure (I.12) show a different technique of atomization [20].

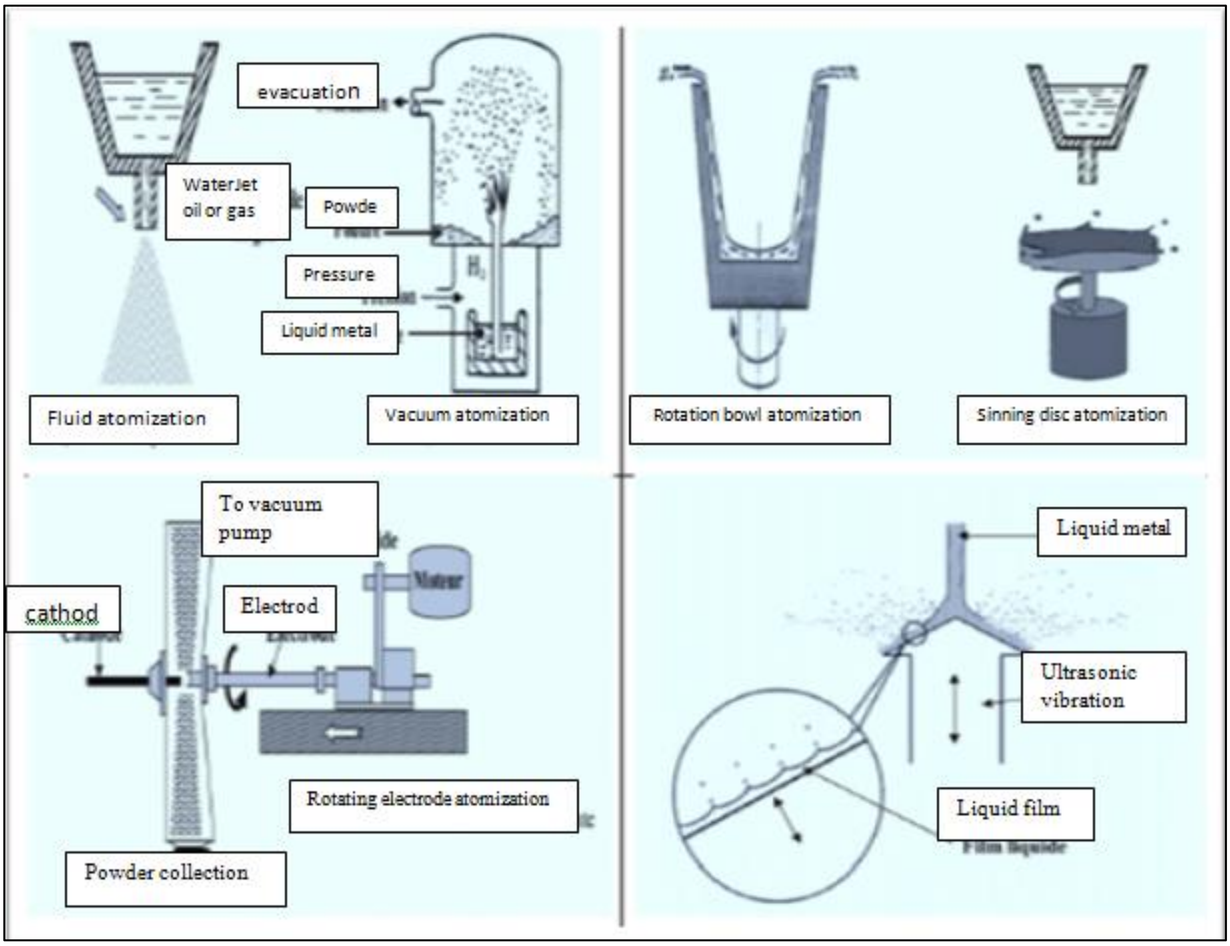

Figure .I.12. Atomization techniques [21].

I.2.6.Compaction

Compaction of powder mixtures is generally carried out using dies machined to close tolerances. Dies are made typically from die steels or cemented carbides. Equipment used for compaction includes mechanical or hydraulic presses, the latter being more common due to their safe operation and flexibility. Die design is important and must ensure easy ejection of compact. The powder type and its characteristics influence the compaction pressure. The basic purpose of compaction is to produce a green compact with sufficient strength to withstand further handling operations. The pressed part, usually called the "green compact," is then taken for sintering. Consolidation of powders may also be carried out at high temperature. Hot extrusion, hot pressing and Hot Isostatic Pressing (HIP) are examples of this category. These methods are used for critical metallic and ceramic components requiring near theoretical density [22].

I.2.7.Sintering

Sintering of the green compact is carried out in a furnace under a controlled atmosphere to bond the particles metallurgically. Sintering is carried out at temperatures about 70% of the absolute melting point of the material. Bonding occurs by diffusion of atoms, giving integrity to the compact. In other words, sintering serves to consolidate the mechanically-bonded powders into a coherent body having the desired service properties. Shrinkage occurs during sintering resulting in densification of the part. This densification enables significant improvements in the physical and mechanical properties of the part. Sintering can be carried out in a variety of fumaces. Mesh belt fumaces are the most common type and are used up to 1,200°C. Walking beam and pusher-type fumaces can be used for still higher temperatures. Batch-type fumaces include bell-type or box-type fumaces. Sintering is normally done under a protective atmosphere. Most commonly used atmospheres include endothermic and dissociated ammonia. Nitrogen is also widely used because of its lower cost [22].

Liquid phase sintering, involving the formation of a liquid phase to enhance sintering kinetics is another type of sintering. This type of sintering requires the presence of a low melting constituent in the compact, with heating being done above the melting point of this constituent. Other variations such as spark sintering, microwave sintering and laser sintering are also adopted for specific applications. Another important development is the Metal Injection Molding (MIM), which has expanded the scope of P/M products tremendously [22].

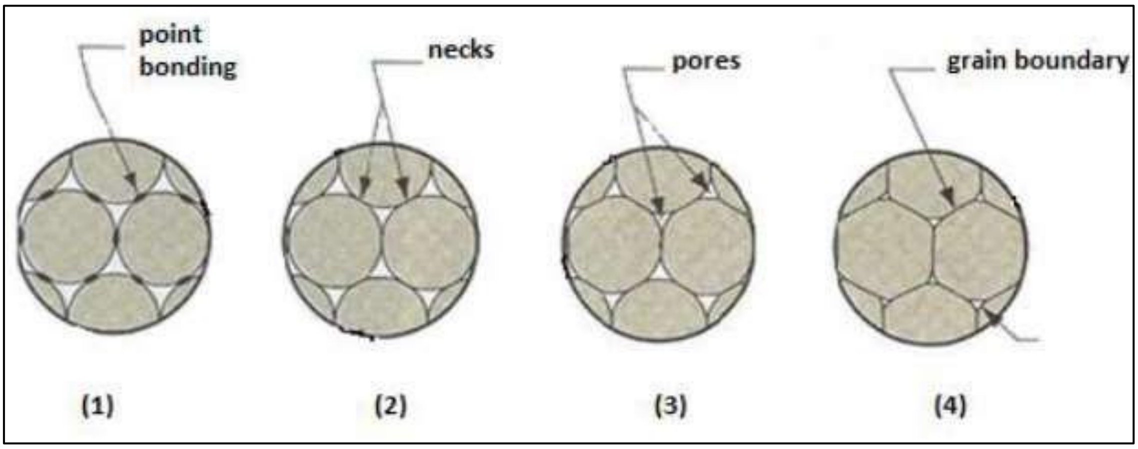

Figure. I.13. Schematic representation of the sintering process on a microscopic scale [23].

I. 3.Electroplating

I.3.1. Definition

Electroplating is a method that involves imposing an electric current between two electrodes or three electrodes immersed in a solution containing a metal salt of the metal to be deposited. Depending on the production conditions (electrolysis bath, pH, conductivity, temperature, additives, current density, continuous regime, pulsed regime ...), it is possible to obtain nanometric grain sizes. This processing technique can have the disadvantage of incorporating into the coating impurities present in the electrolytic solution. These impurities are then likely to strongly influence the physicochemical behavior of the deposit [24].

This synthesis method is often used because it has several advantages: low cost, ease and speed of implementation. The deposits produced have a low level of porosity, grain sizes of 10 nm can be obtained in the presence of additives. It is also possible to obtain coatings with amore or less marked texture [25].

I.3.2.Principle of electroplating

The purpose of electroplating is to apply a surface layer on a metal to give this surface the desired properties: aesthetic, magnetic and or electrical. The principle of electroplating is very simple(figureI.14) : it is electrolysis. This is redox, which are triggered by a current source. Thiselectrochemical method is often carried out using traditional electroplating baths. The electrolysis bath is most of the time, the critical element the appropriate metal salt (sulfates, chlorides or other salts) [25].

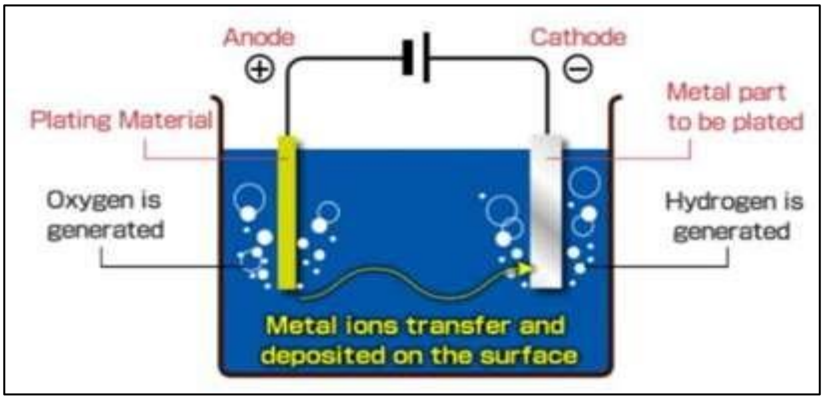

Figure . I.14.Electroplating process .

The substrate (working electrode) on which the deposit is to be made constitutes the cathode of an electrolytic assembly. The electrolyte in which it bathes contains metal ions M "of positive charge. The polarization of the electrodes will cause a migration of these ions towards the cathode, that is to say the substrate. The metal ion is neutralized by the electrodes. Electrons supplied by the cathode and are deposited thereon in the form of metal M following reaction (1) [25].

$$M^{n+} + ne \longrightarrow M \quad (1)$$

I.3.3.Mechanisms of electroplating

The electroplating of a metal on a substrate is a complex phenomenon composed of a succession of elementary steps in series, the slowest of which determines the overall speed of the process. Electroplating processes include the following steps:

I.3.3.1.Mass transport

In this process, substances consumed or produced during the reaction at the electrode aretransported from the electrolyte to the surface of the electrode or from the surface to the electrolyte. The transport of ions in solution can result from:

- **Diffusion,** which is a movement of charged or uncharged species under the effect of a concentration gradient.
- **Migration,** which is a transport of charged species, created by an electric potentialgradient.
- **Convection** is a forced or natural displacement of fluid [26].

I.3.3.2 Load transfer

Charge transfer is a relatively complex mechanism. The ions located in the double layer (area very close to the electrode) undergo Van Der Waals type interactions (long range) leading to physisorption or even shorter range interactions leading to sorption chemistry. These ions, solvates, located close to the electrode / electrolyte interface are then adsorbed. We are talking about additions. A controversy remains, however, as to the different stages that these additions will undergo until their incorporation into the crystal lattice. The theory most adopted is that of Bockris [27, 24].

He (Bockris) explains that additions migrate by surface diffusion to an imperfection in the crystal lattice in order to be incorporated there. It is only after reaching these crystalline sites that the additions desolvate and discharge. They are then incorporated into the crystal lattice. Proponents of the Bockris method thus estimate the mobility of the addition to be greater than that of the adatom. Another theory considers that the desolvation and discharge of additions take place before surface diffusion. Figure 15summarizes the different stages of charge transfer following the Bockris model [28, 24].

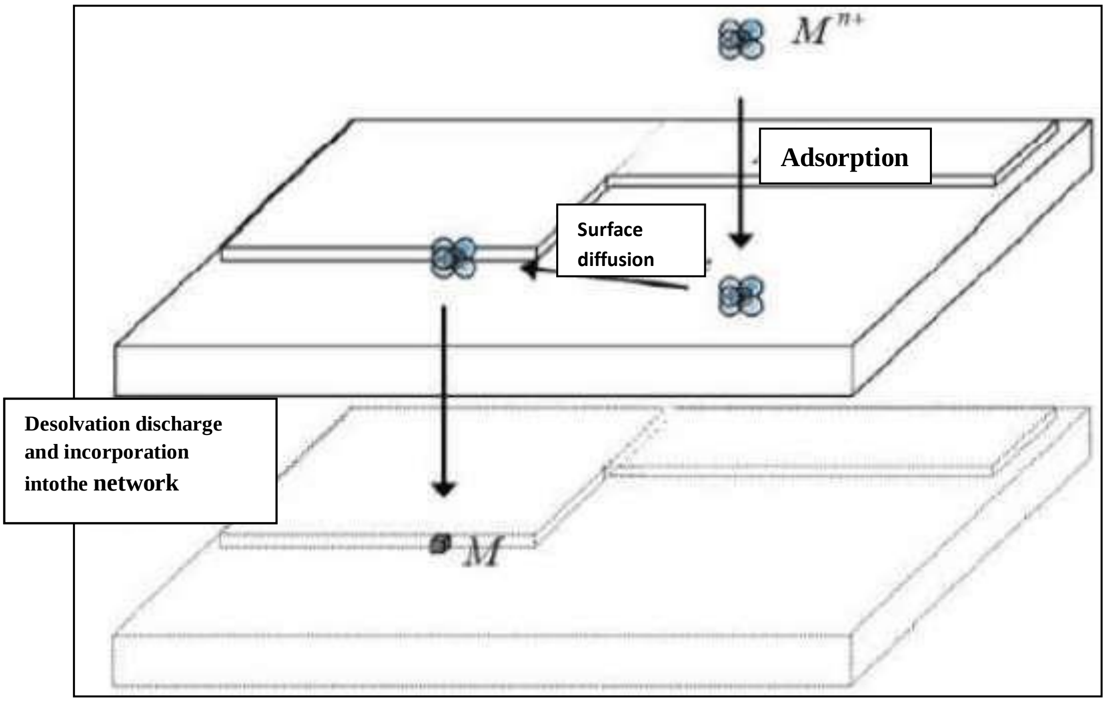

Figure .I.15.Different stages of load transfer.

I.3.3.3.Crystallization

The adatoms will, during this crystallization step, either come to consolidate the crystalline declared under construction, thus promoting the growth of large crystals, or give rise to new crystallites. If the germ growth rate is less than that of nucleation (germination), the deposit will consist of small crystals [29].

I.3.3.4.Other reactions occurring during the electrode process

The charge transfer and the transport of matter are not the only determining stages of theelectrochemical kinetics, it sometimes comes to meet chemical reactions which take place onthe surface of the electrode and which can influence the speed of the reaction as example the electrochemical deposition from a complexed ion [29].

I.3.4.Influence of different factors on electroplating

Different parameters can influence the characteristics of deposits. These parameters are generally classified according to two categories: the initial conditions which are imposed by the experimenter and the so-called temporal conditions which depend on the evolution of the system, (Table.I.2). The role of these parameters is complex and depend on the considered system [30].

Initial conditions	Temporal conditions
-nature of the substrate - substrate preparation -type of anode -electrolyte (concentrations, pH, additives, purity of salts, etc.) - electrical parameters - distance between cathode and anode - agitation - bath temperature - other conditions	-electrolyte (concentration, pH ...) - surface evolution - electrical parameters - side reactions - other conditions

Table . I .2. Conditions influencing the characteristics of coatings [30].

I.3.4.1.Current density

The distribution of current in an electrochemical cell depends mainly on the following factors:

-Electrolyser geometry.

-Conductivity of electrolytes and electrodes.

-Reaction kinetics: activation overvoltage, concentration overvoltage.

In the case where several elements are deposited, the distribution of the partial current densities determines the uniformity of the chemical composition of the deposit and the homogeneity of the thickness [31].

I.3.4.2.Hydrogen potential (pH)

When a metal is electrolytically deposited on a cathode, the deposition of ions of the metal is often accompanied by a deposition of hydrogen ions. When the release of hydrogen is very important, it has a negative influence on the current yield, clone the latter decreases with the increase in acidity. The entrapment of hydrogen in the deposit produces internal stresses which can cause tears in a coating and sometimes even detachment of the coating. (In especially the coating is thick) [32].

I.3.4.3.Influence of temperature

The rise in temperature produces two opposite effects on the structure of the deposit. It leads to an increase in the diffusion speed, opposing the exhaustion of the diffusion layer, thus promoting a fine-grained structure, and a reduction in the overvoltage, and therefore in the Cathodic polarization. However, fine deposits are always accompanied by high polarization. It is therefore a coarse-grained deposit which would tend to form at high temperatures (in general, at medium temperatures, it is the first action that wins, while at high temperatures, the second predominates) [33].

I.3.4.4.Concentration

It is preferable to have few free electro active ions in an electrolyte and to have at the same time a large number of undissociated molecules, serving as a reservoir of metal ions to be deposited. For well-ionized electrolytes, which in the free state contain many electro-active ions, conductive salts are generally added which retrograde the dissociation of the metal salt, also reducing the concentration of free ions while maintaining a large reserve which little dissociate when needed. In complex electrolytes, the concentration of free ion is very low. The equilibrium voltage is then shifted to more negative values, due to the decrease in the concentration of free electro active ions, and the overvoltage increases, resulting in the formation of deposits made up of very thin crystals [32].

I.3.4.5.Organic additives

In electrodeposition, inorganic additions are used in order to change the conditions of electro-crystallization and the properties of electrolytic deposits. The unspecific shiny deposits, the others reduce the surface tension at the metal solution interface and facilitate the separation of hydrogen gas. These substances can be [34]:

- Inorganic anions or cations.
- Oxides and hydroxides.
- Organic cations (amine).
- Organic anions (sulfuric acid).
- Neutral organic molecules with a large deposit.

Chapter II

Experimental methods

II.1 Introduction

In this chapter we will describe the main elements designed by Solidworks. Solidworks iscomputer aided design software. It uses the parametric design principle and generates three types of related files: the part, the assembly, and the drawing. Thus any modification on one of these three files will be reflected on the other two. It allows us to sketch our ideas and experiment with different designs to create 3D models using the intuitive Windows graphical user interface.

II.2 Schematic representation of the mechanism:

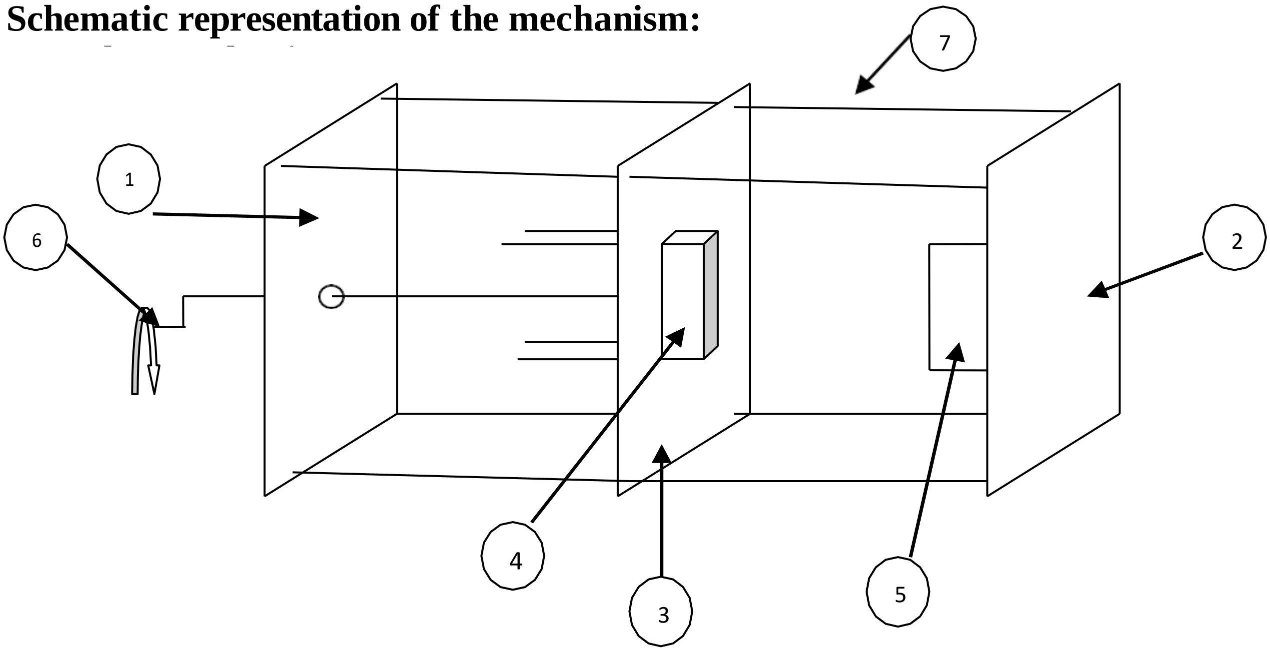

Figure II.1: schematic representation of the mold.

My work in this thesis is to realize and to design by Solidworks a mold of the Gadgets for Biskra University (fig II.1).

The main mechanism parts are:

1.2: Fixed plates

3: moving plate

4: Upper die

5-Bottom die

6-Threaded rod

7-Sliding bars

II.3.Mold elements design:

The constituent parts of our mold were designed by Solidworks software; you may check the anex for the complete detailed drawing of all parts.

II.3.1. Choice of materials:

The elements of the mold are manufactured from A60 steel due to it's good mechanical properties.

II.3.1.1.Mold:

The mold consist of the following parts:

1- The upper die is a plate 200mm in length, 150mm in width and 20mm in thickness. It contains four holes for fixing it to moving plate (shows figure II.2), as well as the holes through which it passes the ejection piston. It also contains a casting channel and four cavities connected to conduits for air exit.

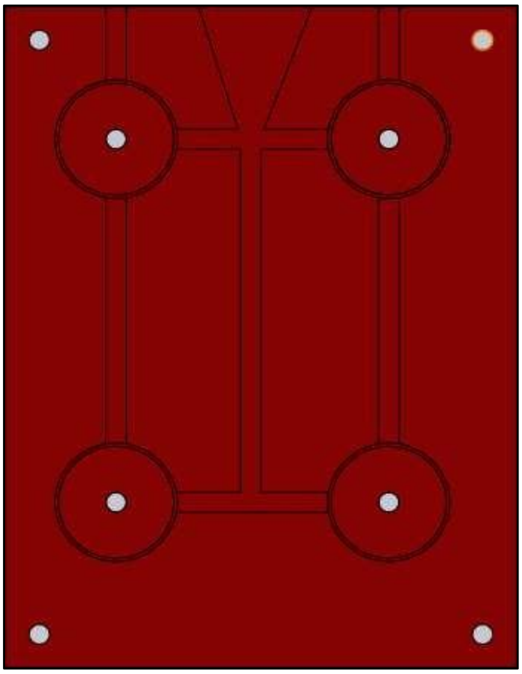

Figure II.2.Upper die.

2-The bottom die it’s a plate with four holes to be installed by bolts in plate N°2 Figure (II.3). Its length is 200mm, its width is 150mm, and its thickness is 10 mm.

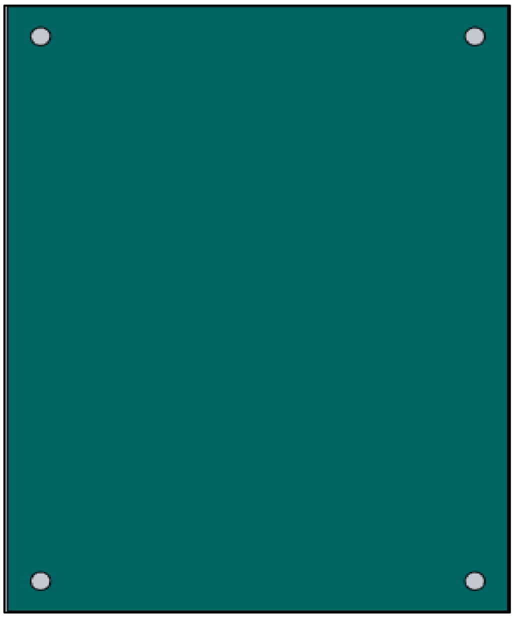

Figure II.3.Bottom die.

2- The mold also has four ejection pistons (figure II.4) placed on the upper mold in the cavity center, these pistons play a big role in the series production as it reduces the ejection time and prevent the solidified material from sticking to the mold.

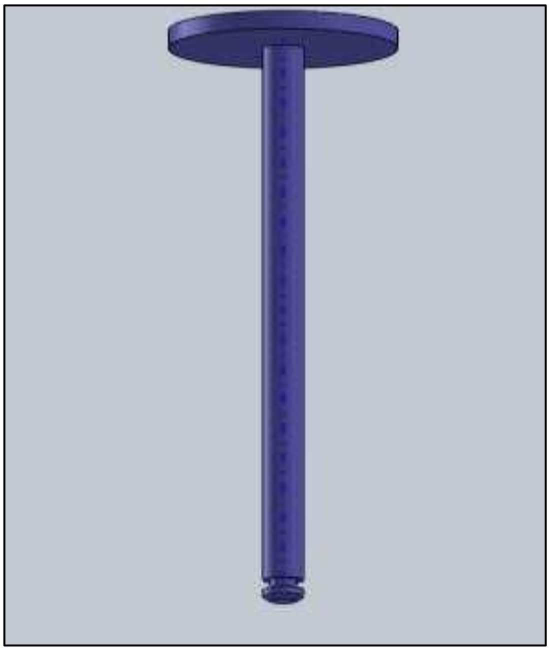

Figure .II.4.Ejection piston

4-Assembly of the mold

As we can see in the figure (II.5) the assembly of the components of the mold where each element is placed in its place. We pass the pistons through the holes in the upper die.

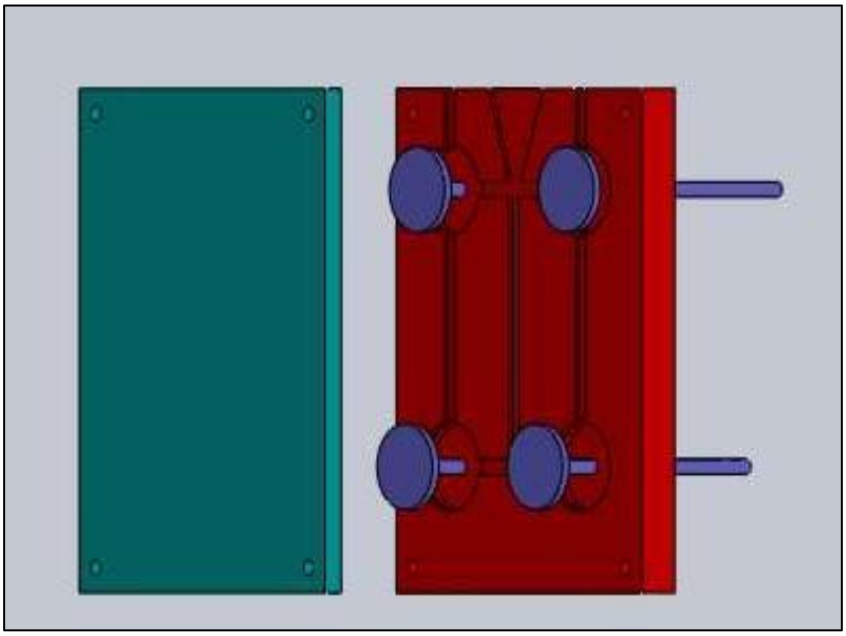

Figure II.5. Assembly of mold

II.3.1.2-Casting mechanism (opening/closing):

The Casting mechanism consists of:

1-The plate number 01(figure.II.6) is fixed plate, its length is 300mm, its width is 250mm and its thickness is 15mm. It contains four holes of diameter 20mm, through which the sliding bars pass and are fixed with screws, it also contains a hole in the middle that passes through it threaded rod.

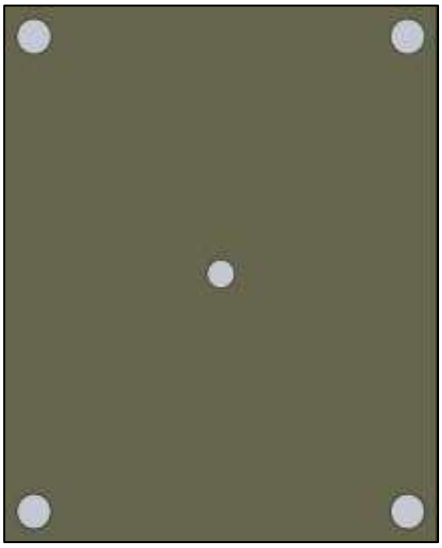

Figure .II.6. Fixed plate.

2-The plate number 02 (figure.II.7) is fixed plate. As a same dimensions as the plate 01His plate is the one that holds the bottom die.

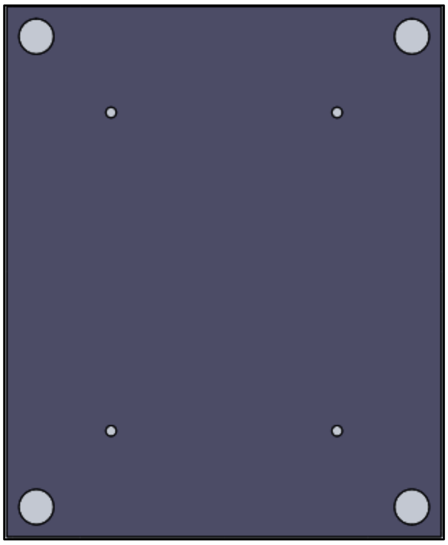

Figure .II.7. The fixed plate holding the bottom dies.

3- The fixed plate (figure.II.8), (same dimension as plate 1and 2), this plate holds the upper die.

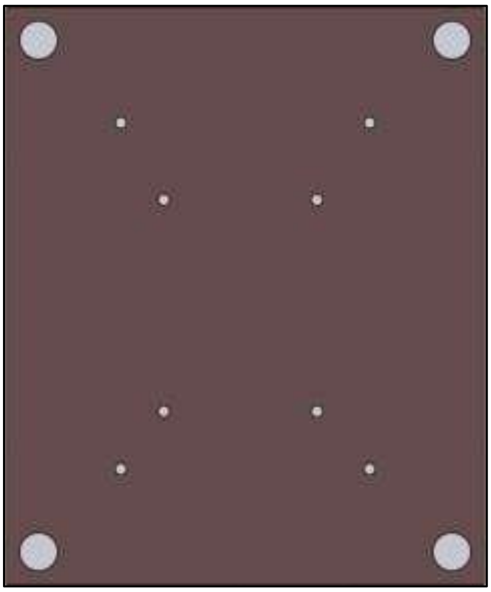

Figure .II.8.the moved plate holding an upper die.

4- Sliding bar

We have four bars linking platelets to each other (figureII.9).

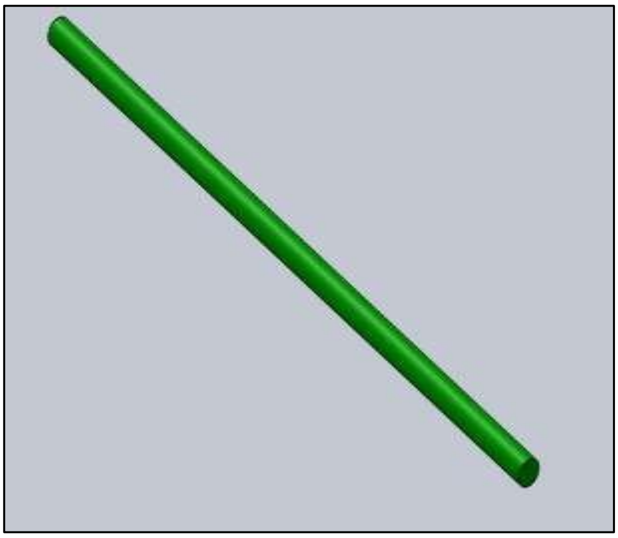

Figure .II.9.Sliding bar.

5-Threaded rod

It passe through the hole of first plate and installed on the second plate in order to move it (figureII.10).

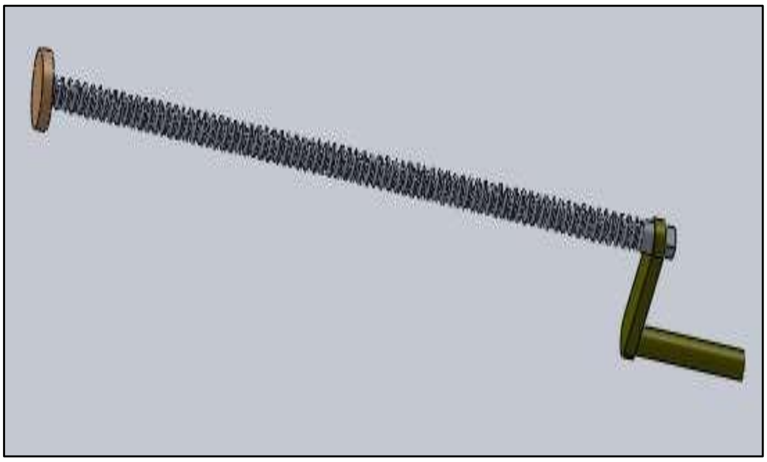

Figure.II.10.threaded rod

6-Lid

This cover (figure.II.11) allows the plate to move during rotation

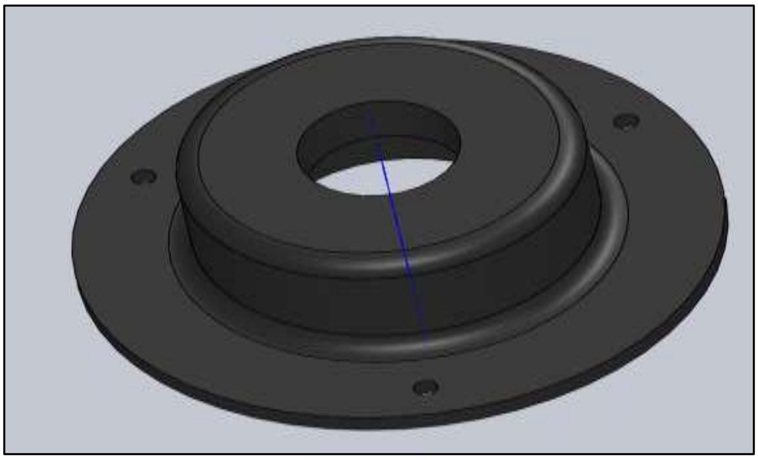

Figure.II.11.lid

Assembly of casting mechanism (opening /closing)

We shows in the figure (II.12) the assembly of the components of casting mechanism.

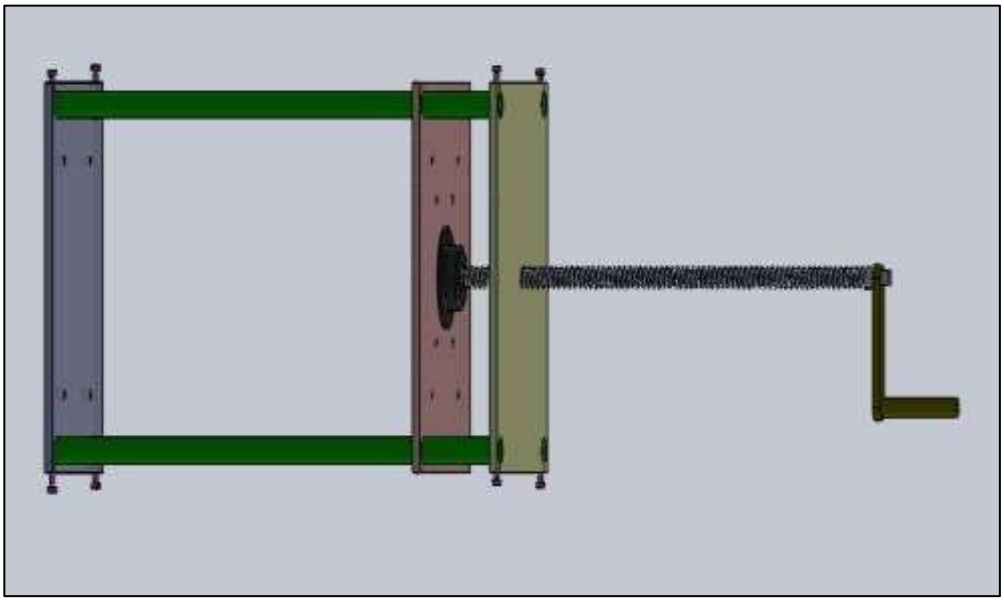

Figure .II.12. Assembly of casting mechanism (opening/ closing).

II.3.1.3-Mold assembly carried out

Figure (II.13) shows the final form of the mold after assembly. The mechanism of this mold works as follow:

We rotate the threaded rod (figure.II.10) which transforms the motion to the moving plate (figure.II.8) in order to open or close the mold (figure.II.5) by sliding on the bars (figure.II.9) .Then we will pour the melted metal through the casting channels. We wait few minutes to allow the molten Aluminum to solidify, after that, we open the mold by rotating the threaded rod. The ejection process starts when the ejection pistons are blocked against the fixed plate (figure.II.6) the moving plate (figure.II.8) will continue sliding towards the fixed plate (figure.II.6) allowing the casted material to be ejected from the mold. When closing the mold, the spring press the ejection pistons back to their initial position inside the mold. The process is repeated for every casting operation.

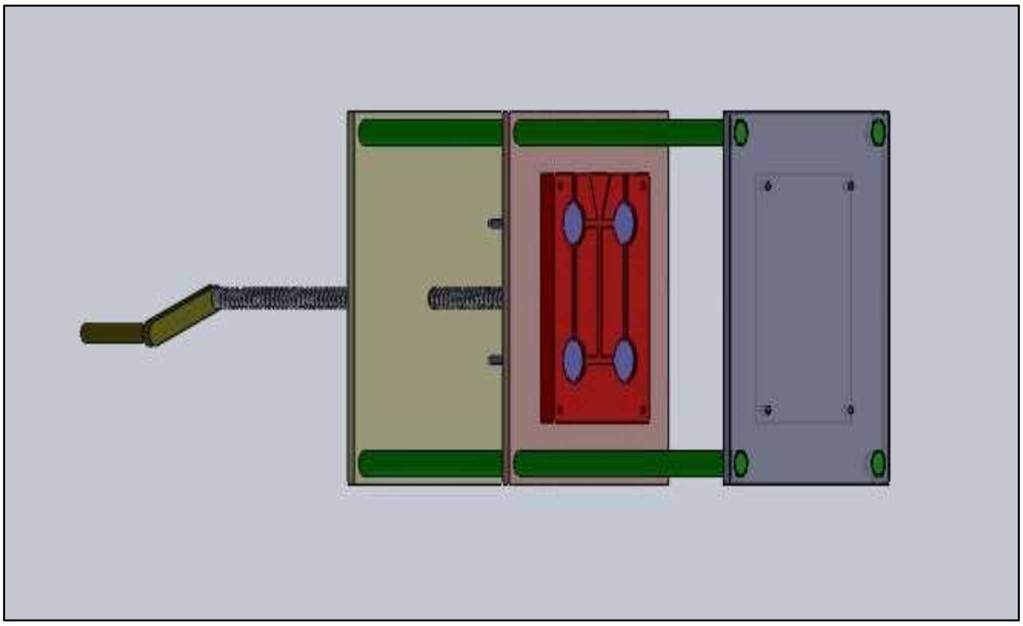

Figure II.13: mold assembly carried out

Chapter III

Results and discussion

III.1.Introduction

In this chapter, we will present the manufactured mold and discuss the mold mechanism and technical problems that we faced.

III.2.Creation of the mold

During this work we could fabricate the designed casting mold to 85% as we faced many technological problems due the lack of manufacturing tools(figure.III.1)

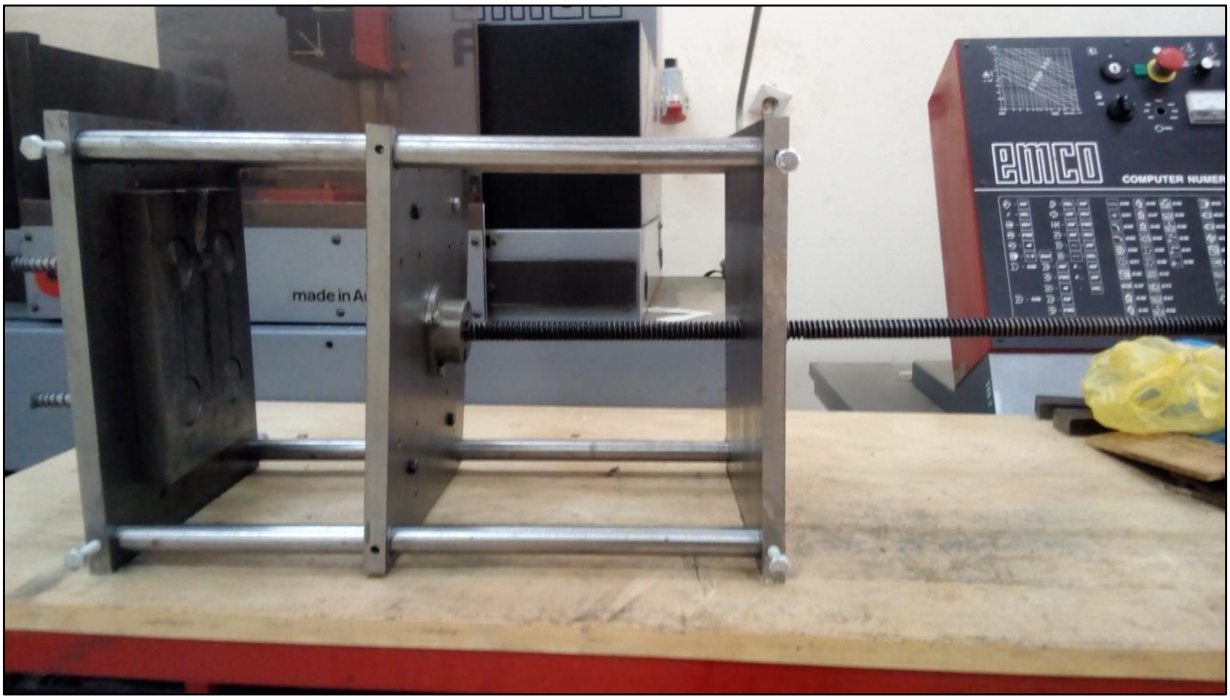

Figure III.1 the manufactured mold .

The mold is formed from many parts as it is explained bellow:

First, the mechanism that holds the mold (figure.III.2)

It consists of three plates connected to each other by four bars, two of the plates are fixed by screws and the third is free /moving. the plate number (1) holding the bottom die, and the plate moving holding the upper die .Then, the mechanism also contains a threaded rod that enable the plate to move in order to open or close the mold.

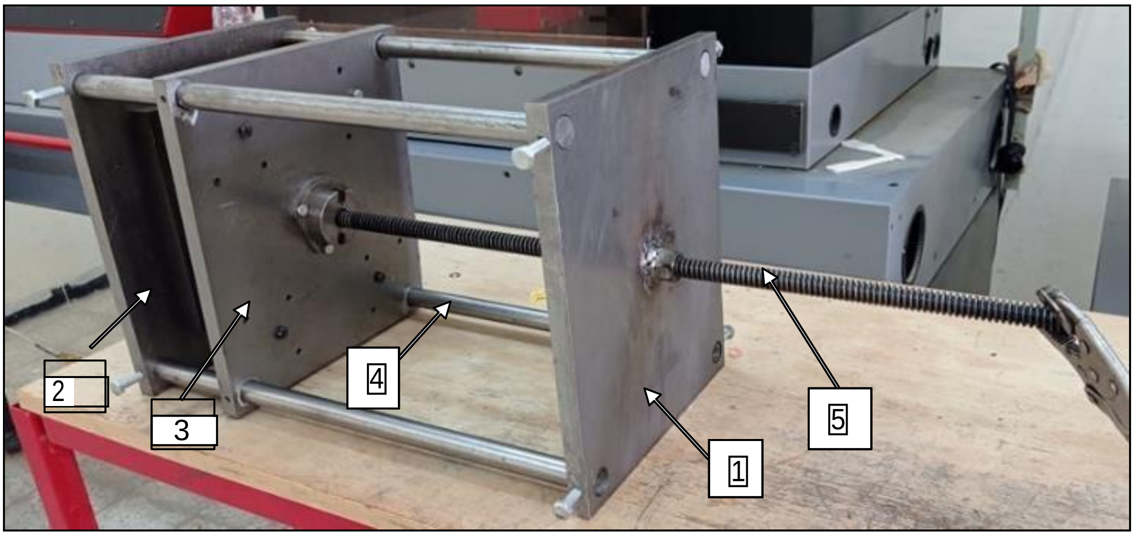

Figure .III.2.The elements that make up the mold

1, 2-Fixed plates

3- Moving plate

4- Sliding bars

5-Threaded rod

The second part is the mold die it is consists of tow plates, the bottom and upper die .

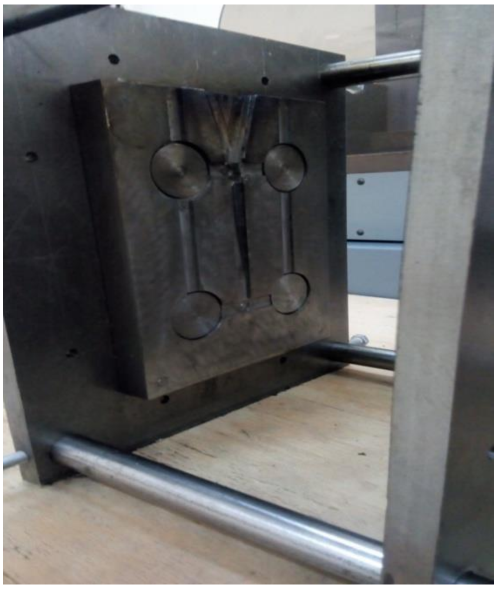

Figure .III.3.bottom die creating

.**Figure .III.4. Upper die creating.**

-Then, we carried out a preliminary operation of molding aluminum parts.

-The parts obtained were not very satisfactory but, this operation showed us that the grooves of the upper die were not sufficient deep.

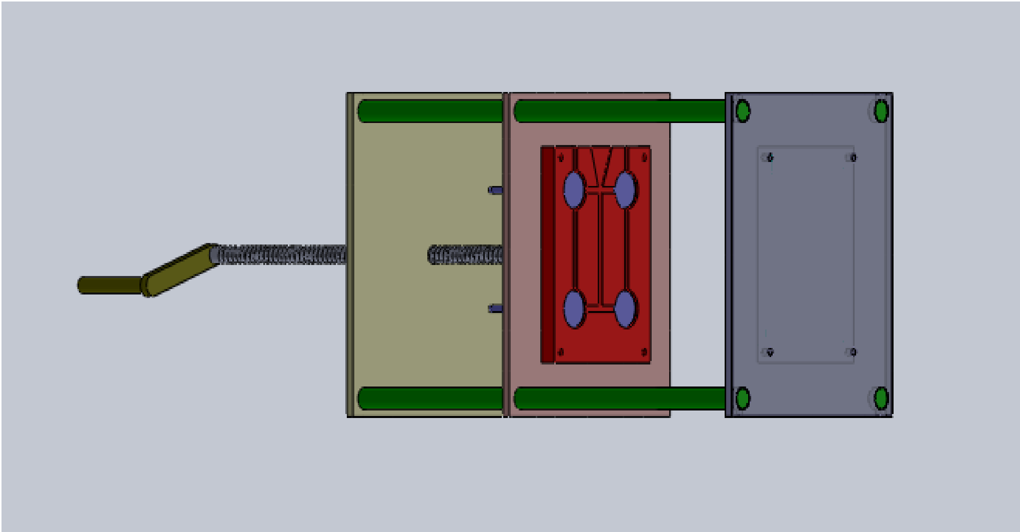

Figure.III.5.The mold designed by Solid works.

General conclusion

During this work we could design a permanent casting die for Aluminum/ Zinc gadgets for Biskra University using Solid works Software. The detailed designed parts and assembly are provided in the annex.

We fabricated the permanent Die using A60 steel, the process took long time due to the lack of the necessary equipment but eventually we could realize it.

The mechanism was primarily designed for injection molding but due to the actual situation we changed the design for gravity casting design.

The first attempts of casting were not successful because of couple of reasons:

1- the lack of equipment; the die needs to be well preheated, we had only one torch to melt the Aluminum and heat the mold both operations take long time, as a result the Aluminum was solidifying before filling the mold.
2- The connecting cavity for pouring the molten Aluminum needs to be wider for gravity casting.

As a solution both operations must be done at the same time and larger groves mast be added in order to avoid the solidification of Aluminum before filling the mold cavity. Also, a lubrication is recommended before each operation.

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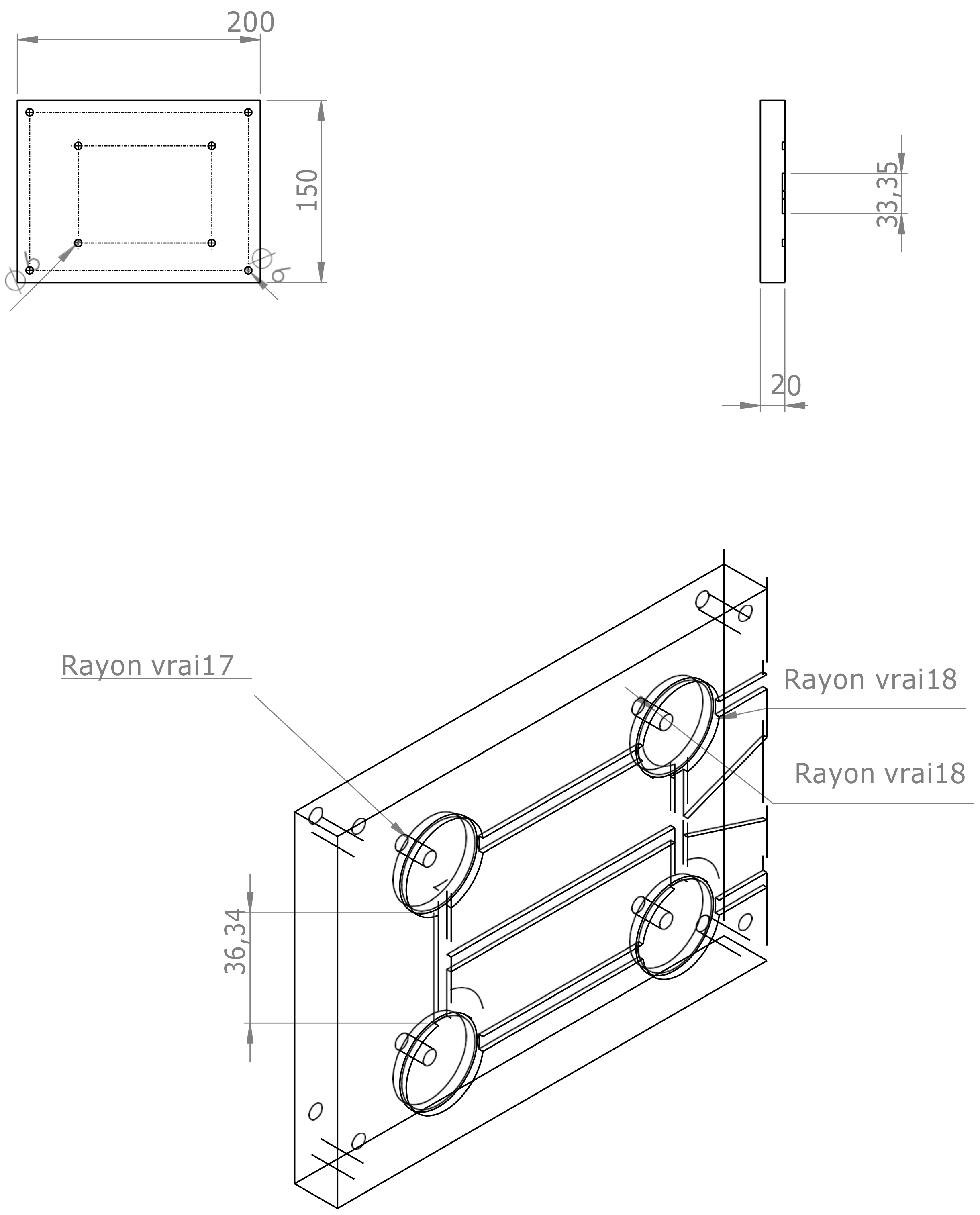
Annex



Student:
Khaoula Traka

Mohamed Khider University
Biskra

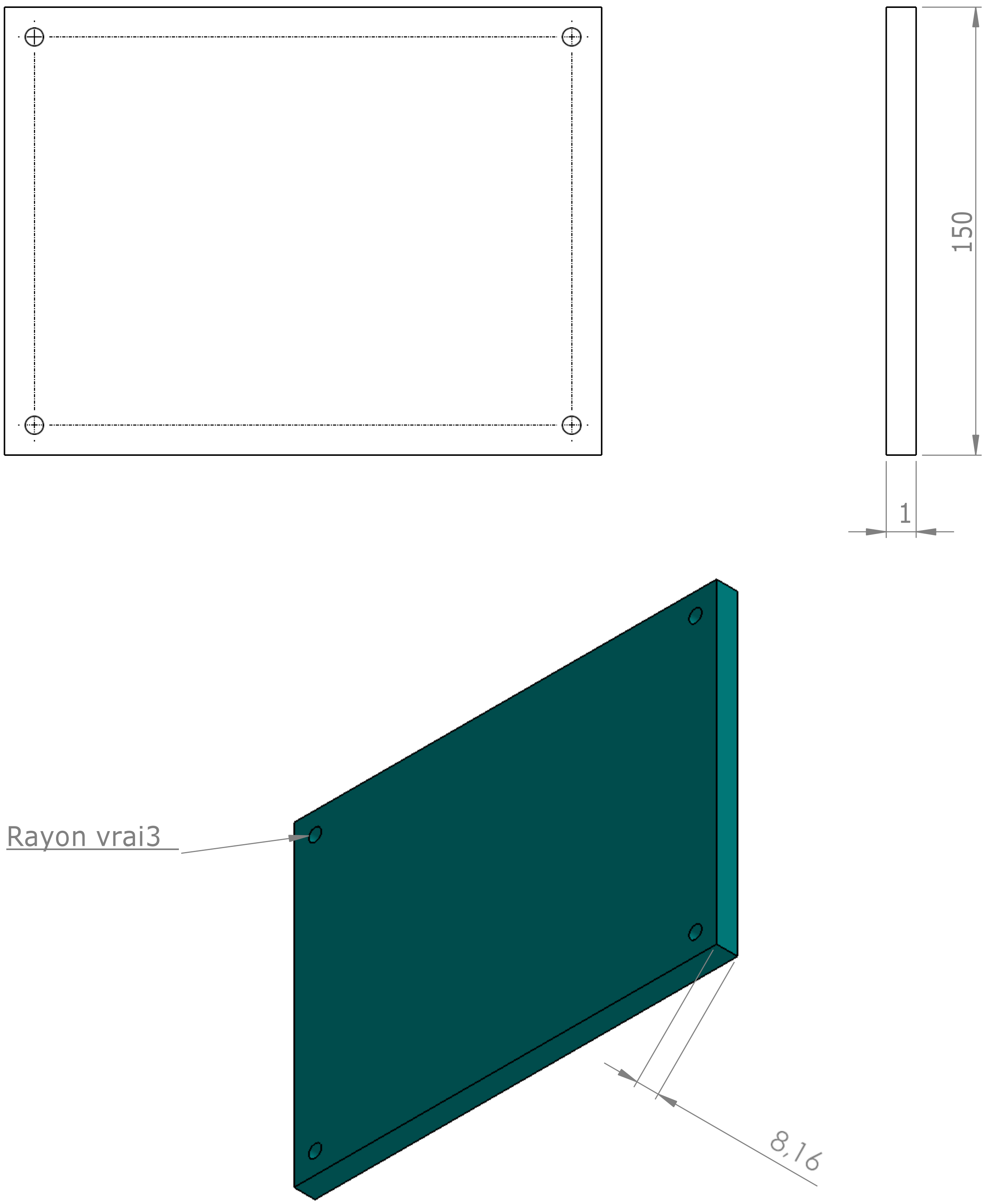
Department Mechanicale
Enegineering

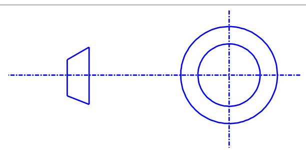
Dr.Ben Zine Haroun Rachid

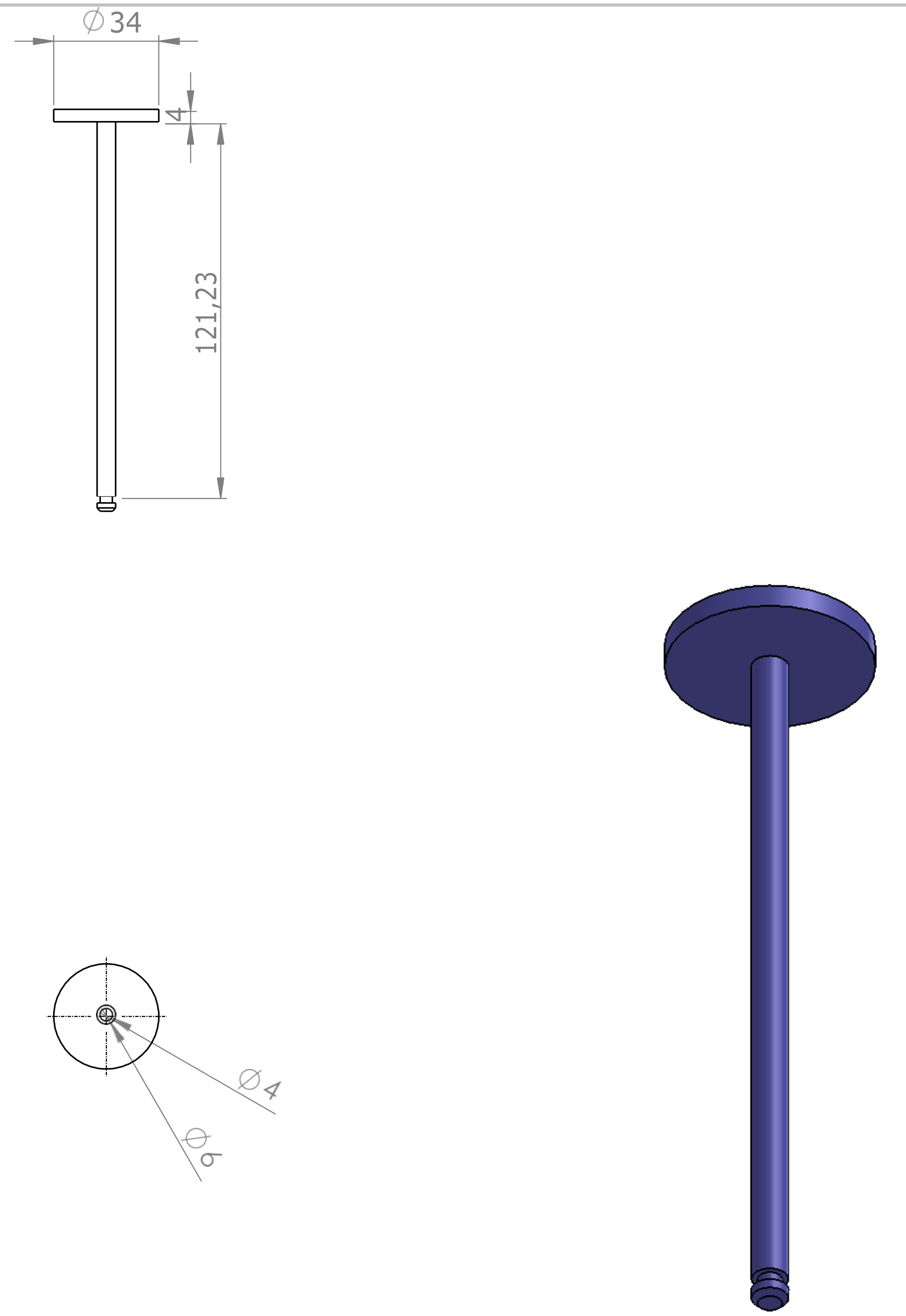
Upper die

Master dessertation

Date :06/26/2021



Student: Khaoula Traka	Mohamed Khider University Biskra	Department Mechanicale Enegineering
Dr.Ben Zine Haroun Rachid	Bottom die	Master dessertation
		Date :06/26/2021



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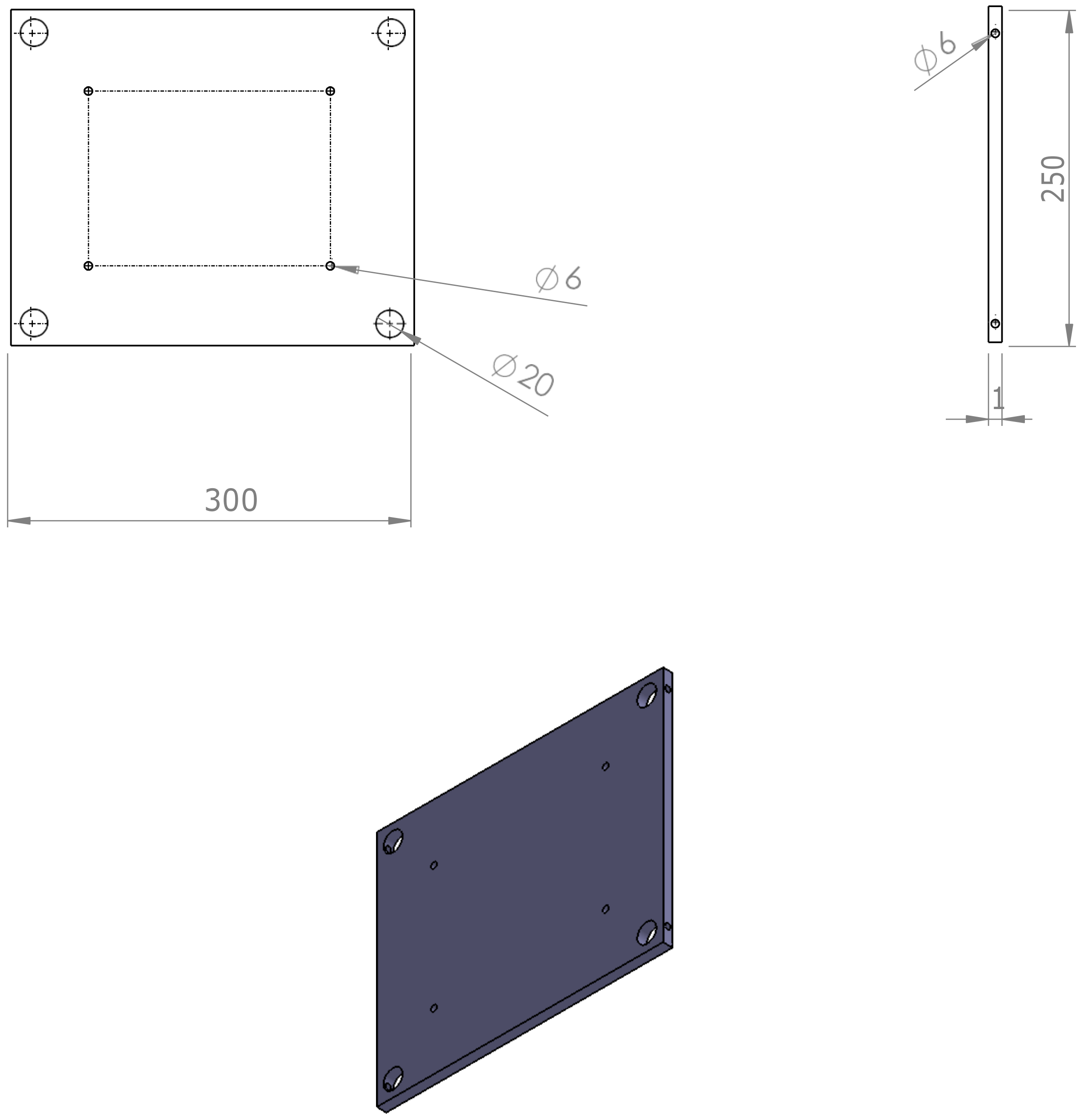
Dr.Ben Zine Haroun Rachid	Ejection piston	Master dessertation
		Date :06/26/2021



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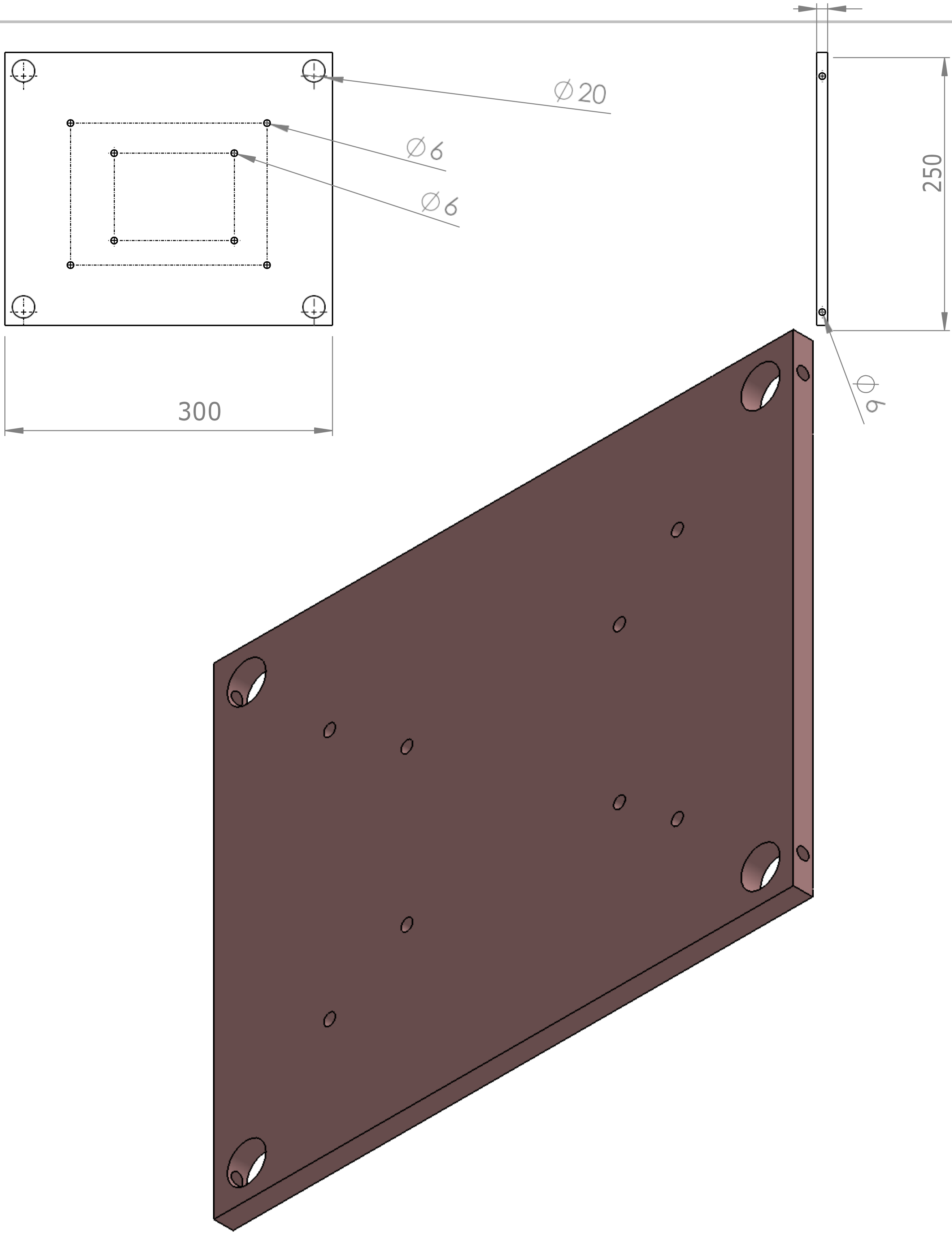
Dr.Ben Zine Haroun Rachid	Fixed plate 2	Master dessertation
		Date :06/26/2021



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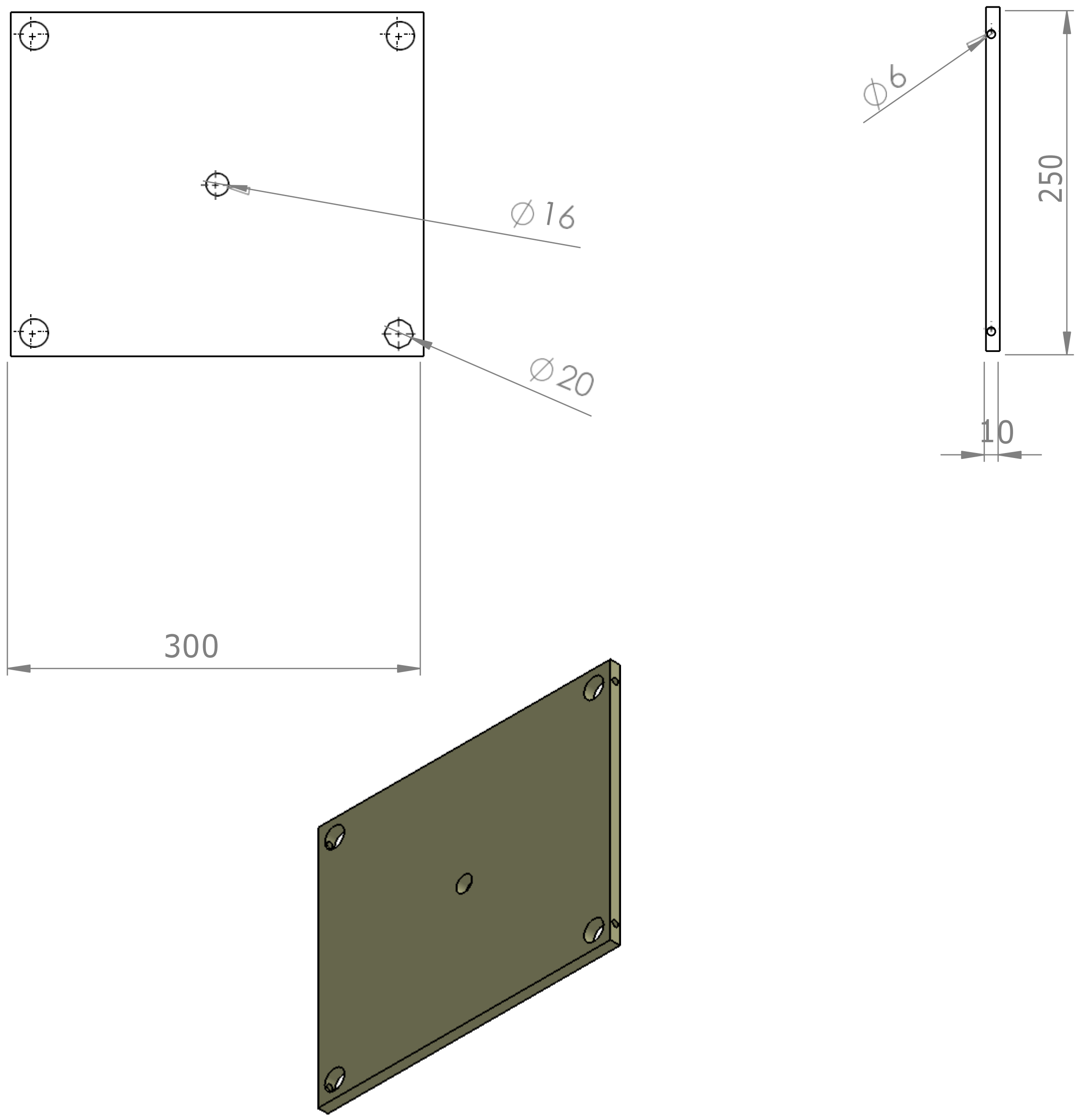
Dr.Ben Zine Haroun Rachid	Moving plate	Master dessertation
		Date :06/26/2021



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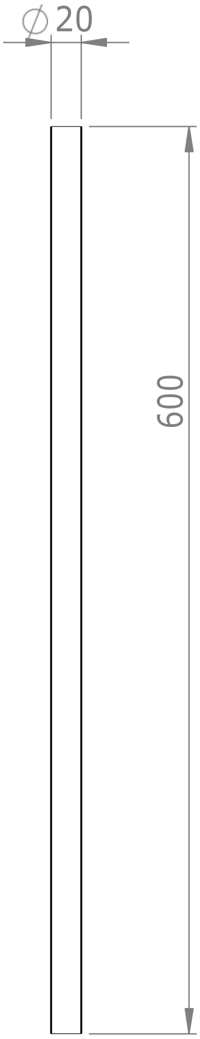

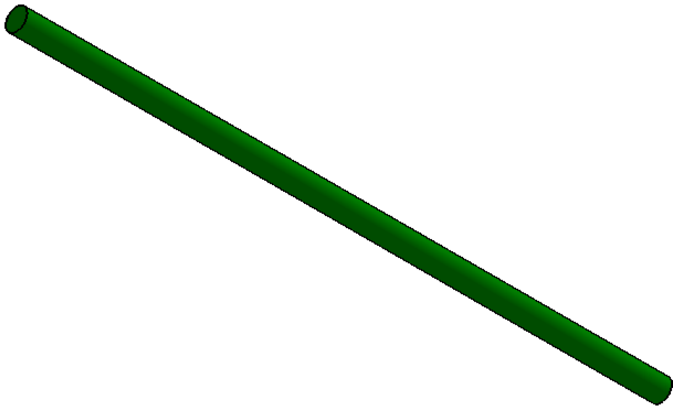

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Dr.Ben Zine Haroun Rachid	Sliding bar	Master dessertation
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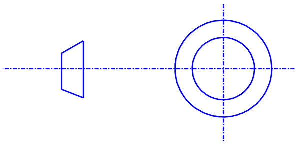

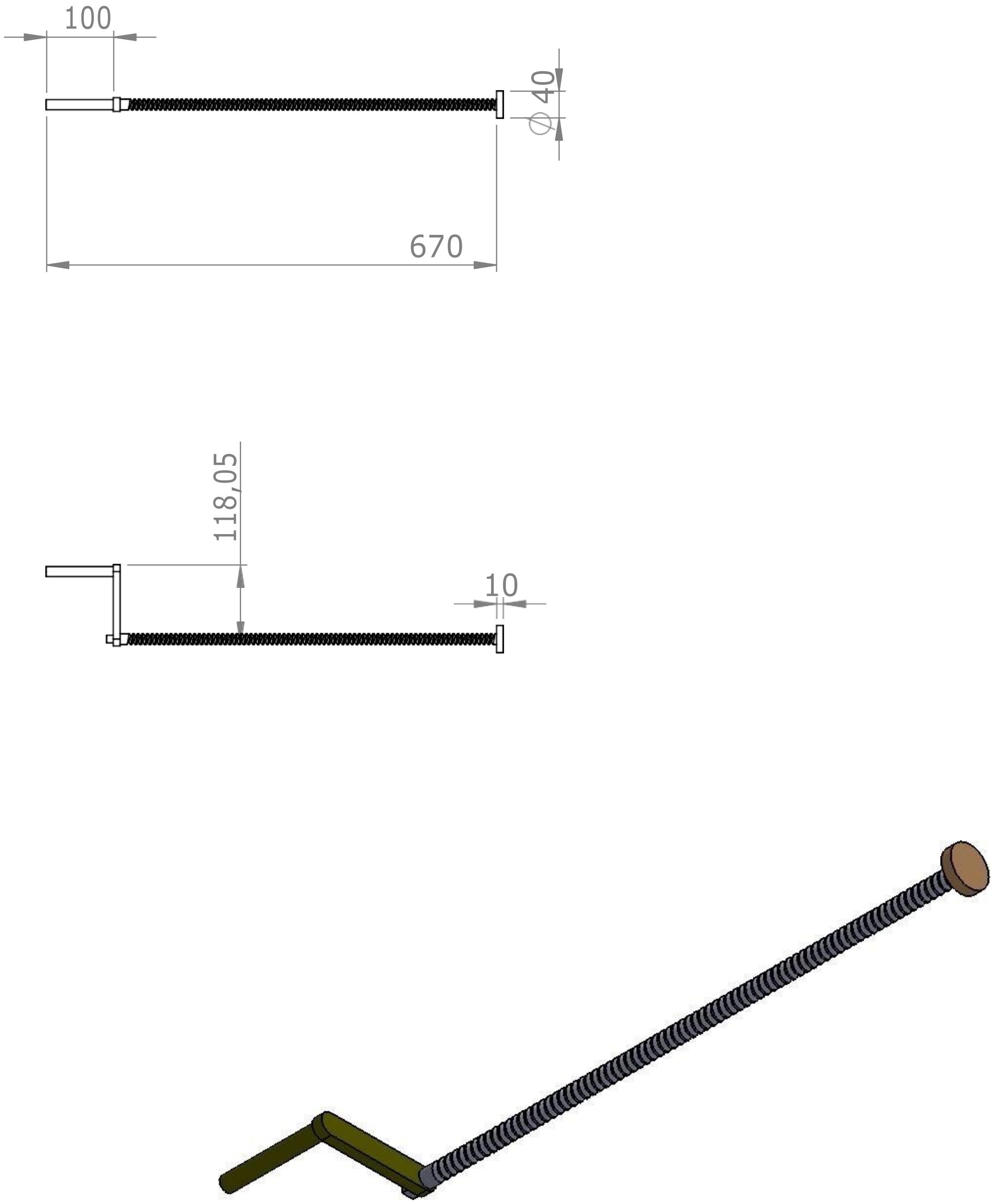

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Dr.Ben Zine Haroun Rachid	Threaded rod	Master dessertation
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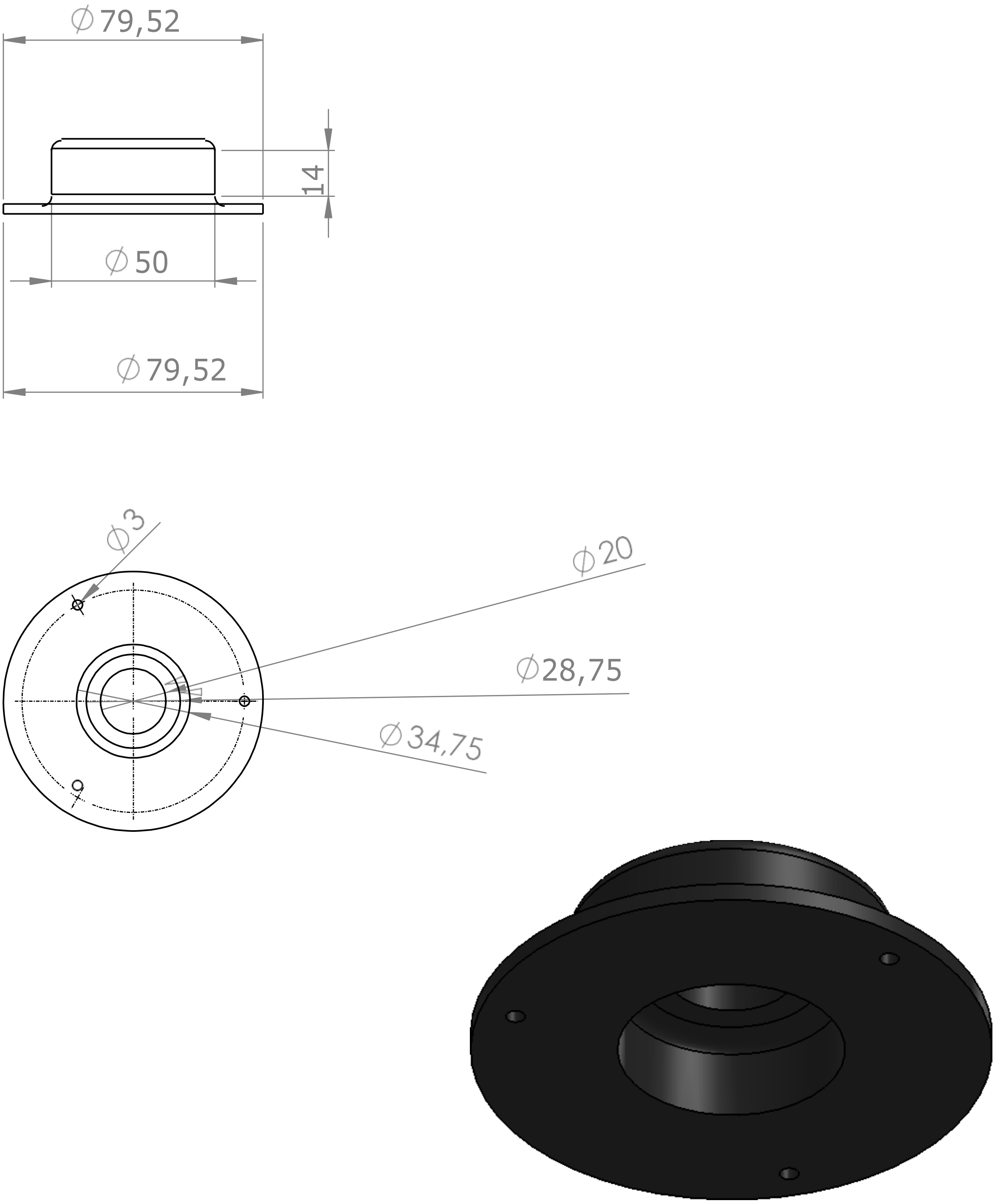

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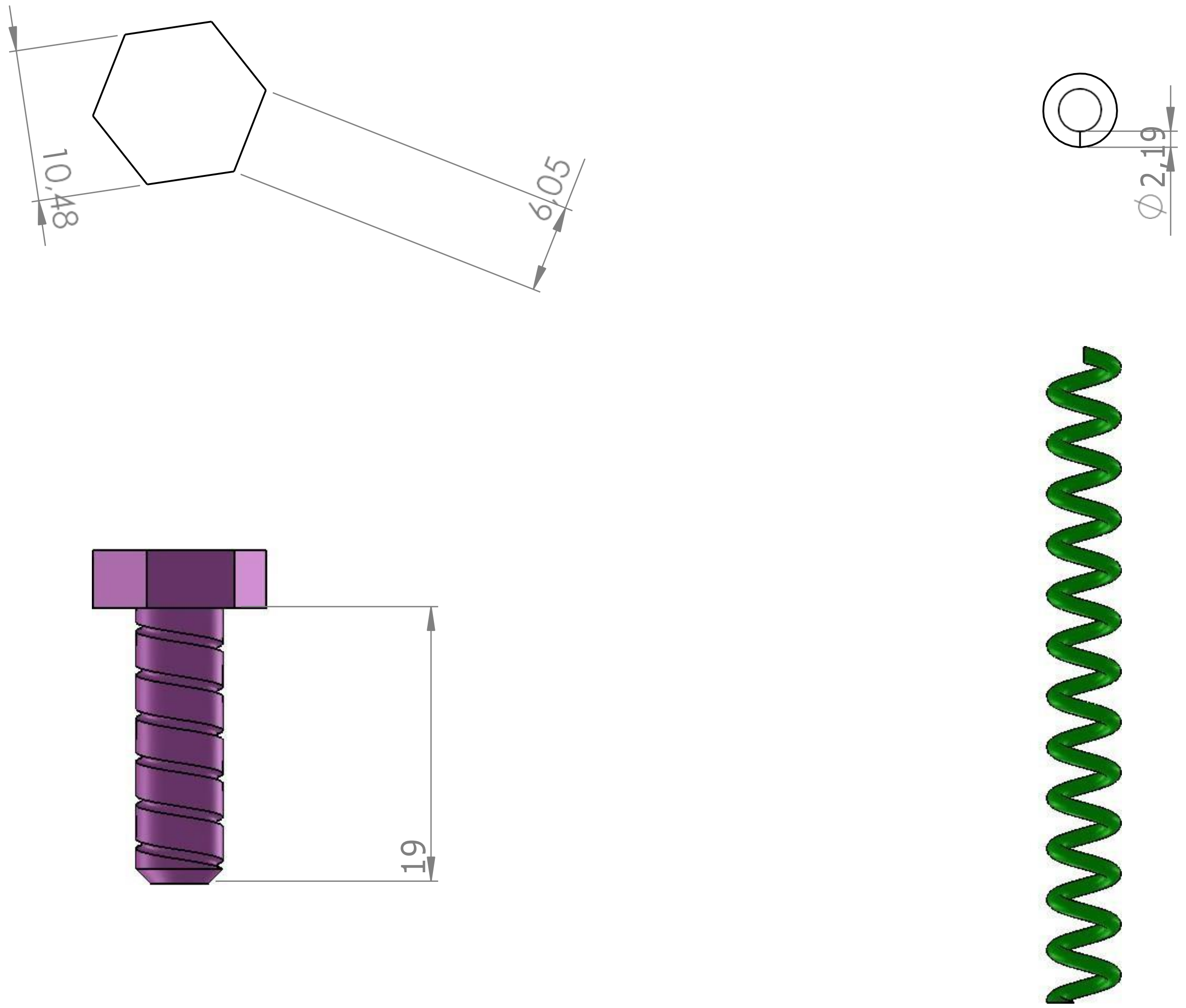
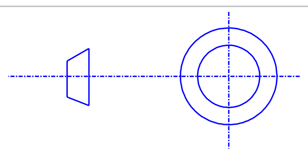
Dr.Ben Zine Haroun Rachid	Lid	Master dessertation
		Date :06/26/2021





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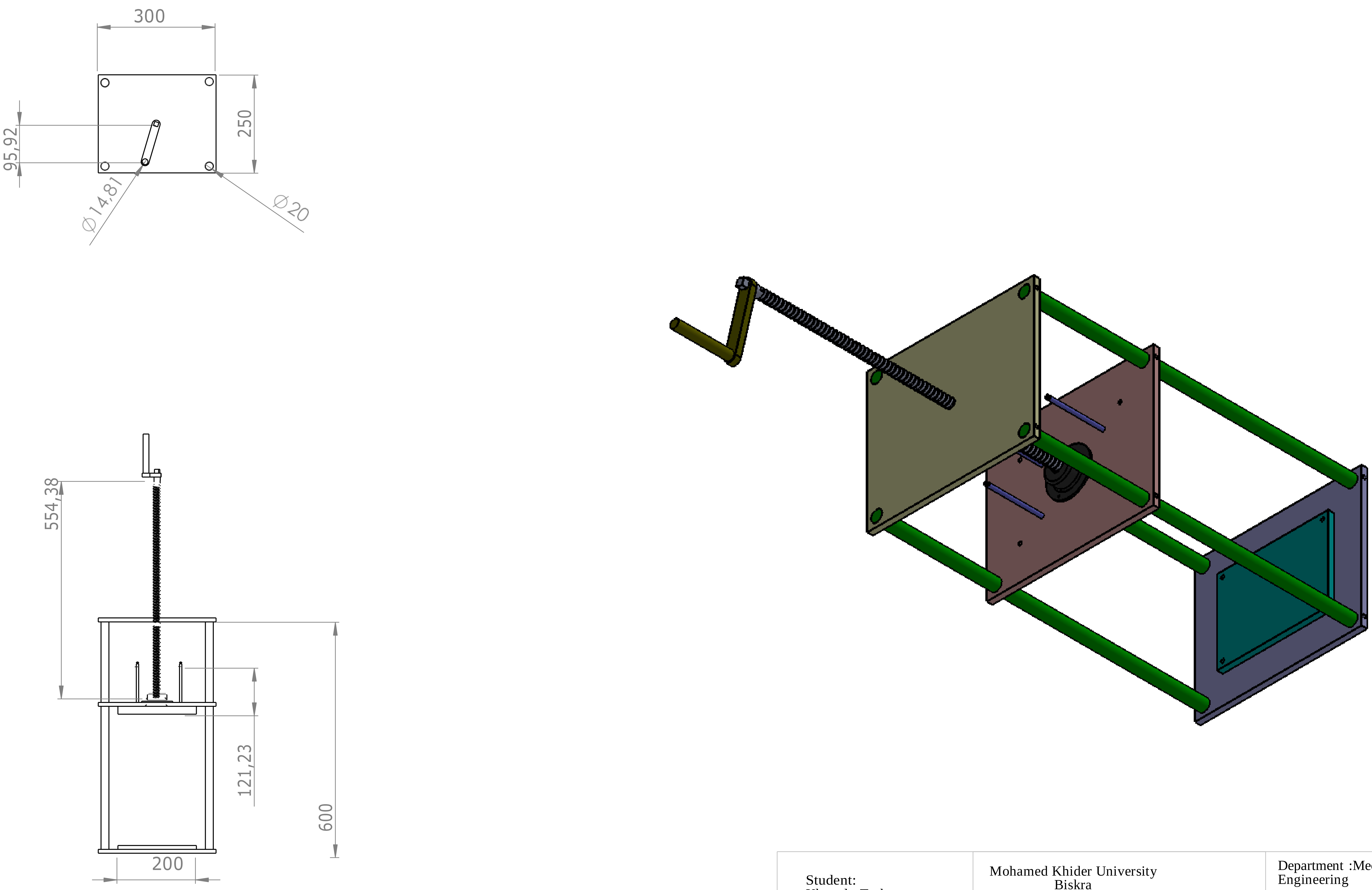
Dr.Ben Zine Haroun Rachid	Screw Spring	Master dessertation
		Date :06/26/2021



Student: Khaoula Traka	Mohamed Khider University Biskra	Department :Mechanical Engineering
Dr.Ben Zine Haroun Rachid	Assembly of the mold	Master dessertation
		06/26/2021

التلخيص

الهدف من هذه الأطروحة هو تصميم وتطوير أدوات (حاملات الحقائب وخواتم المفاتيح) لجامعة محمد خيضر

خلال هذا العمل، تمكنا من تصميم مصفوفة صب دائمة لأدوات الألومنيوم / الزنك لجامعة بسكرة باستخدام برامج الأعمال الصلبة. وترد الأجزاء المفصلة والتجميع في المرفق .

لقد صنعنا المصفوفة الدائمة باستخدام الفولاذA60 ، واستغرقت العملية وقتا طويلا بسبب نقص المعدات اللازمة ، ولكن في النهاية تمكنا من تحقيقها.

تم تصميم الآلية أساسا لحقن صب، ولكن نظرا للحالة الحقيقية، غيرنا تصميم الصب الجاذبية .

لم تنجح محاولات الصب الأولى لعدة أسباب:

-نقص المواد. يجب تسخين القالب جيدًا ، لم يكن لدينا سوى شعلة واحدة لصهر الألومنيوم وتسخين القالب ، تستغرق كلتا العمليتين وقتًا طويلاً ، وبالتالي فإن الألمنيوم متصلب قبل ملء القالب

-2 .يجب أن يكون تجويف التوصيل لصب الألومنيوم المصهور أكبر للصب بالجاذبية. كحل ، يجب إجراء كلتا العمليتين في نفس الوقت ويجب إضافة أعمدة أوسع لتجنب تصلب الألومنيوم قبل ملء تجويف القالب. يوصى أيضًا بالتزييت قبل كل عملية

Abstract

The objective of this dissertation/ work is to design and elaborate Gadgets (Bag Holder and keys Holders) for Mohamed Khider University

During this work we could design a permanent casting die for Aluminium/ Zinc gadgets for Biskra University using Solid works Software. The detailed designed parts and assembly are provided in the annex.

We fabricated the permanent Die using A60 steel, the process took long time due to the lack of the necessary equipment but eventually we could realize it.

The mechanism was primarily designed for injection molding but due to the actual situation we changed the design for gravity casting design.

The first attempts of casting were not successful because of couple of reasons:

1- the lack of equipment; the die needs to be wellpreheated, we had only one torch to melt the Aluminium and heat the mold both operations take long time, as a result the Aluminium was solidifying before filling the mold.
2- The connecting cavity for pouring the molten Aluminium needs to be wider for gravity casting.

As a solution both operations must be done at the same timeand larger groves mast be added in order to avoid the solidification of Aluminium before filling the mold cavity. Also alubrication is recommended before each operation.

Résumé

L'objectif de cette thèse est de fabriquer et d'élaborer des gadgets (porte-sac et porte-clés) pour l'Université Mohamed Khider .

Au cours de ce travail, nous avons pu concevoir une matrice de coulée permanente pour les gadgets aluminium / zinc pour l'Université Biskra en utilisant Solid works Software. Les pièces et l'assemblage détaillés sont indiqués en annexe.

Nous avons fabriqué la matrice permanente en utilisant de l'acier A60, le processus a pris beaucoup de temps en raison du manque d'équipement nécessaire, mais finalement nous avons pu le réaliser.

Le mécanisme a été principalement conçu pour le moulage par injection, mais en raison de la situation réelle, nous avons changé la conception de la conception de la coulée par gravité.
Les premières tentatives de casting n'ont pas été couronnées de succès pour plusieurs raisons :

1- le manque d'équipement ; la matrice doit être bien préchauffée, nous n'avions qu'une seule torche pour faire fondre l'aluminium et chauffer le moule les deux opérations prennent beaucoup de temps, en conséquence l'aluminium se solidifiait avant de remplir le moule.

2- La cavité de connexion pour couler l'aluminium fondu doit être plus large pour la coulée par gravité.

En tant que solution, les deux opérations doivent être effectuées en même temps et des mâts de bosquets plus grands doivent être ajoutés afin d'éviter la solidification de l'aluminium avant de remplir la cavité du moule. Une lubrification est également recommandée avant chaque opération.