

GOLD CHAIN COLLET DESIGN, MANUFACTURING AND EXPERIMENT ON CNC MACHINE FOR THE PURPOSE OF JEWELRY DESIGN

Dharmil Lavingiya¹, Kamlesh Kadiya²

¹ PG student, Masters of CAD/CAM, LJJET-Ahmedabad, Gujarat, India

² Assistant professor, Mechanical engineering, LJJET-Ahmedabad, Gujarat, India

Abstract: This paper proposes a new concept and enhances jewelry designing in CNC machine. From last decade because of industrial revolution and availability of machine technology like CNC, jewelries like bangles and rings are designed in CNC machines but we can't design chains in CNC machine. All kind of ornaments are not in usage in all culture and all places around the world, only the chains are, because chains are widely used ornament and different types of chains are famous through different ethnicity, religion and culture. But we can't design chains in CNC. We only have few semi-automatic machines which can be used for the purpose of chain machining and designing. But the issue is we only able to perform linear and circular shaped grooves in designing of chain. We can't make curvy grooves design. Curvy grooves designing are only possible with the help of machine like CNC machine. We have already machine support, tool support and software support using in designing bangles and rings. We only need is a proper gold chain attachment or chain collet design. For this research we are using CNC as Machine support, SolidWorks 2014, CorelDraw as software support. The purpose of research is to design the chain collet which is suitable for CNC machines, then for authenticate the design phase we will fix it in CNC machine and by generating CRD and plotter (PLT) file we will machined a gold chain on the CNC machine. The experiment also contain the defect analyzing in chains before perform engraving on chains. So, purpose of the research is to make a proper new path of procedural way of designing chains in CNC machine.

Index Terms: CNC collet, Jewelry designing and manufacturing, CNC components, Gold chain manufacturing, Gold chain in CNC.

I. INTRODUCTION

Gold chains are widely used ornaments all over the world. All kinds of ornaments are not used in all country there are many reasons as religion, fashion, culture, but the chains are used in all over the world in all country. In today scenario we design chains in horizontal and vertical cutting machine. In that machine the limitation is that we only engrave lines and circular holes and grooves only. All variants of design have this common entity lines and circles. We have more other entity like curves, which can provide marvelous look to the chain designing. But the problem is that, we can't use curves because horizontal and vertical cutting machine is manual. Manually we can't create such detail designing.



(a)



(b)

Fig- 1 (a) Horizontal and vertical cutting machine, (b) Jewelry CNC machine

The above figure (a) is of Horizontal and vertical cutting machine. It contains 2 spindles. Horizontal spindle cut linear geometry and the vertical spindle makes circular designs and holes. The table can be moved manually so curves can't be designed. There are different types of chain available like Venetian chain, curb chain, box chain, foxtail chain, snake chain, Cuban chain etc. So, there must be collet which can hold all kind of chains. Also there is variety based on thickness and size. Thus we basically need collet on which all the variety of chain can be mounted on CNC machine as shown in figure (b).

Now a day, there are intelligent computer systems available, which can be used for jewelry design and support [1]. In CNC machines Bangles, rings and chains can be designed and there are number of software available for the purpose of designing jewelry like 3Design, Rhinoceros, Matrix, and CorelDraw etc [2]. Designing Bangles (Both Curved [3] and Fret [4]) the system and the changes in the CNC machine is available for make a CNC machine adaptable for designing jewelries on it. The crux of availability of SSS (Software, System & support), if we design a collet for chains we will be able for the designing chains in the CNC machine. For designing chain collet we must go through the basics and solve 3 questions. 1) What will be its mechanism? 2) What will be minimum and maximum chain fitting size limitations? 3) How it will be fitted in CNC machine?

1.1 CNC MACHINE COMPONENT DETAILS

CNC which are used in ornaments making are different then the other machine which are used in industry as discussed above, for understanding more about CNC machine below is the specifications and features of CNC machines.

- Control System: Windows 8 with a attach motion control card
- Axis Motors: X - Y - Z - Z1 - Z2 - C1 - C2 - B - O - T - R - 400 Watt
- Spindle Motor: 1, 5 kW 60.000 speed/min.
- Pen Motor: 0.55 kW min. 12.000 rpm max 20.000 rpm AC motor
- Surface Motor: 0.55 kW min. 12.000 rpm max 20.000 rpm AC motor
- B axis working area: 0-90 0+45 0
- Sizes and weight: 105 x 85 x 185 cm 950 kg

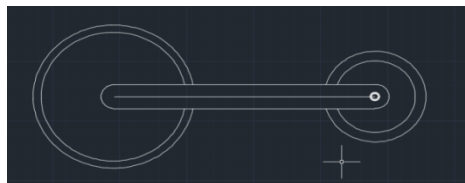
1.2 CNC MACHINE FEATURES

Table-1 CNC machine feature

No	Part/specification	detail
1	Working spindle	2 (1 Horizontal, 1 Vertical)
2	Axis	X = linear (flat surface)
		Y = Bangle rotation
		A = rotating (degree axis)
		B = rotating (table axis)
		C = cutter axis
		D = rotating (half round bangle)
		Z1 = horizontal linear
		Z2 = vertical linear
9 th = auto changer		
3	Spindle speed	20000-60000 RPM
4	Motor power	0.5 to 5 hp

2. DESIGN OF GOLD CHAIN COLLET

Chains are flexible in construction; it is not rigid like bangles and rings. It is more complicated to construct collet for such flexible structures like chains. We have many mechanisms for chains; the very first and basic one is used in bicycles. There are two probates and a chain by moving paddle chain gets rotational motion. The second one mechanism used is of power transition in machines.



The figure 2 shows the given and a plate holding the

Fig- 2 Basic mechanism of chain collet

bicycles have. The basic design of chain collet in figure is made by using AutoCAD 2015. For making the design there are few parts and sub-components designed as shown in the figure 3. The assembly of the seven components is given in the figure 4. The design and assembly of the components are made in Solid Works 2014.

basic mechanism in which two pulleys are both pulleys, this is same mechanism as

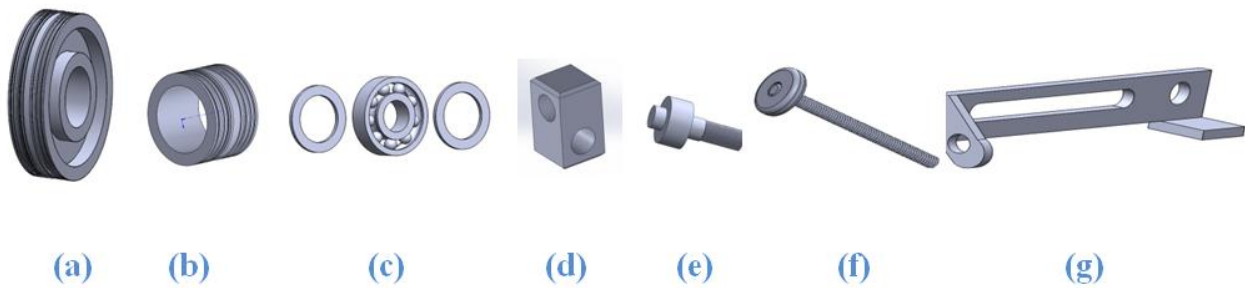


Fig- 3 Component designs of chain collet

The construction of the chain collet as per figure 3, all seven components are shown by which the chain collet is made. The (a) and the (b) in figure 3 are main 2 pulleys on which chain will be fitted. The main pulley (a) will be fitted on the spindle of head stock. The driven pulley (b) will be fitted on the main plate (g). Both of pulleys are fitted with bearing (c) inside. One bearing holding pin is designed to make a contact between pulley and the bearing shown in (e). The driven pulley (b) and the threaded rod/ adjustable screw (f) are joined by dual holed block (d).

Chains are basically of different cross section and of different size. Basically as per a survey 80% of chains in markets are between 14 inches to 25 inches. There are only a few chains which are longer than this size. So, the chain collet is made like all size of chains are can be fitted on single collet.

The working of chain collet is very simple. Chain is fitted between two pulleys, in required slot, there are 6 numbers of slots are given for different cross section of chains. The adjustable screw (f) is helping to tighten the chain. The collet is to be fitted on head stock of the CNC machine. The spindle of head stock rotates the chain collet. The horizontal or vertical spindle will perform machining on the chains. There are different machining operations is to be perform on chains like engraving, slotting, grooving, finishing, cutting, drilling etc.

The operations like engraving drilling, hole making is the work of vertical spindle and the operations like slotting, cutting etc is the operation of the horizontal spindle. So as requirement of operation, bed is moved below horizontal or below vertical spindle. The machining is done by tool fitted in one of the spindle and designed is done by choosing tool as required. The minimum machining width is around 0.1 mm. so; micromachining is also possible in CNC machines. The assembly of the chain collet is shown as below figure.

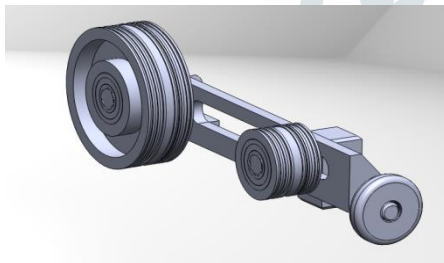


Fig -4 Assembly of chain collets



Fig- 5 Assembly of collet of changed plate design

Sometimes it is not possible; that we got space for fixing chain collet every time below the headstock. So we need alternative plan to fixing the chain collet to other orientation. In such a way that the rigidity of collet also be maintained and the collet works in its proper way as before. For the purpose of solving this issue changing the design for usage in conditions like less space below the heatstroke, machine construction is congested; there is no more space between the headstock and table of the machine etc.

2.1 PROBLEM IN CHAIN COLLET DESIGN

All mechanism and machines has area of improvement, or a way by which improves its operation & machining capability. After making the chain design with a view to 2 different condition and orientation, we delivered the chain design to the well known company VEKARIYA Engineering works in Jamnagar, Gujarat, India through mail. The respected production manager Mr. Ratnesh identifies few problems in the previous chain collet design shown in Fig (4) & (5). We got guidance and area of design on which we can do improvement. There are basically 2 types of chain collets design problem is in observation that can be resolved by making other possible changes in collets design. The problems are following.

Problem 1) - We need to remove chain collets for fitting any other collets:-

If we want to machine a ring or a bangle after working on the chain collets, then we need to remove the 2-3 bolts for remove collets and then we can fit the other collets of ring and bangles.

Problem 2) - The limitation on size of chain:-

The 80% of chain is between 14 to 25 inches but the rest of 20% can't be machined by this collets. So, making the collets as all size of chain can be fitted on it.

2.2 IMPROVED DESIGN OF CHAIN COLLET

New design of chain collets contains a flexible mechanism which is more effective than the previous designs. For the purpose of make able the chain collets to hold all different sizes of chains the Driven pulley must be flexible to move away from the driver pulley. The design of components of the new chain collet design is shown as below figures. There is total 5 numbers of components shown in below figure. The Design of block part will be fitted below the head stock and the hole given in this will be fitted with the rod. The degree of freedom of the block will be zero with respect to the rod.

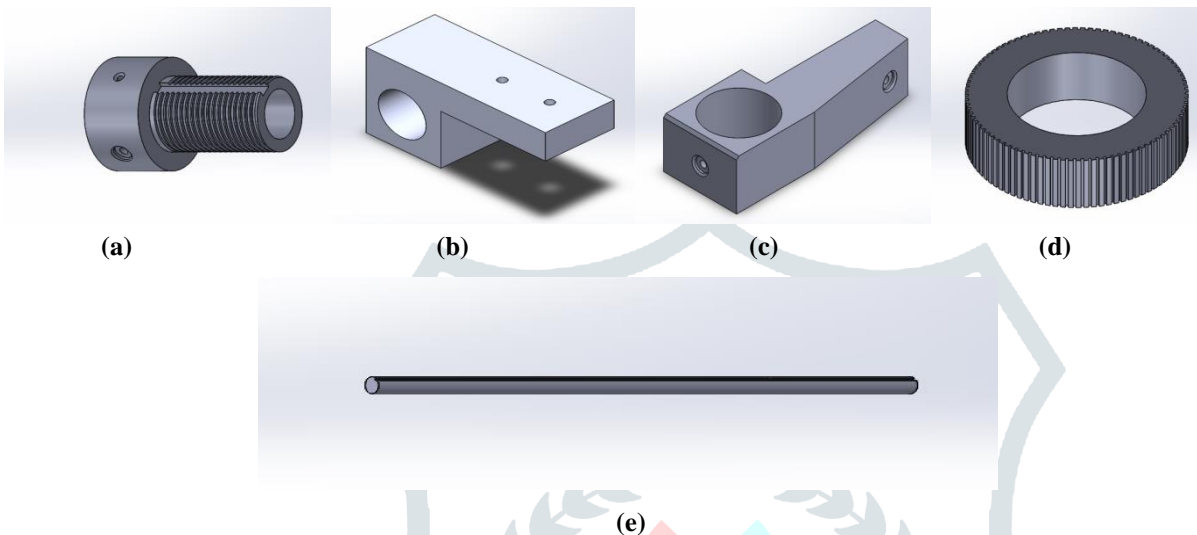


Fig – 6 Component design of the new chain collet

The Fig 6 (a) shows the hollow threaded part which will be used for sliding over the rod shown in fig 6 (e), Fig 6(b) shows the design of block part, it will be fitted below the head stock and the hole given in this will be fitted with the rod. The degree of freedom of the block will be zero with respect to the rod. Lock ring is shown in the fig 6 (d), the work of lock ring is to fix the part shown in fig 6 (c) in threaded hollow part which shown in fig 6 (a). This design is final and satisfies the all problem comments. So, it the assembly of the above part in CAD designing and in actual manufactured model is shown in the below figure.

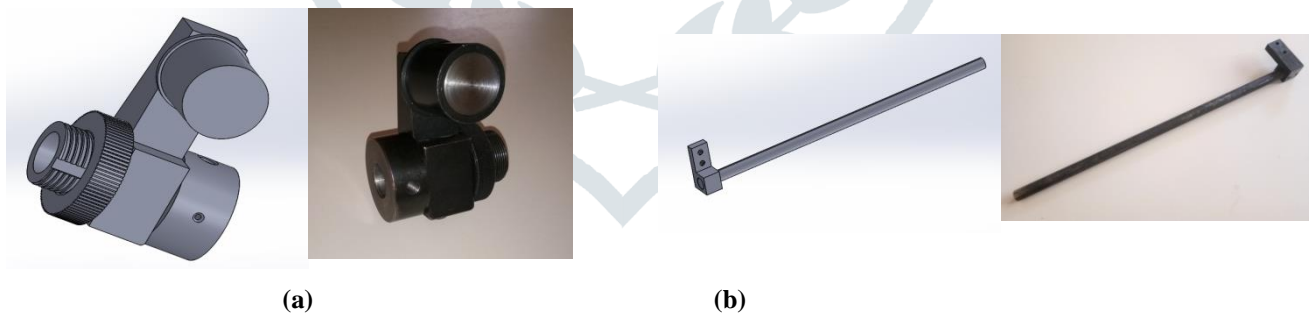


Fig – 7 CAD file of assembly of the chain collet and original component made as designed

3. UTILIZATION OF CHAIN COLLET

There are specially 2 holes made below the head stock. The dimension of holes on collets is exactly same as dimension of hole below the head stock. There are 2 bolts used for fitting chain collets. The Driver pulley is fitted on head stock. The sub assembly can be sliding on the rod, so by sliding the driven pulley chain can be fitted. By tighten bolt given on the sides of the driven pulley the distance can be fixed. By rotating the driver pulley the driven pullet will also get the motion. And the chain continuously gets motion.



Fig - 8 Attaching collet in CNC machine

3.1 MACHINING THE CHAIN IN CNC USING CHAIN COLLET

Utilizing the new design made by solving all issues shown in Fig 7, and by the above figure we fix the chain collet on the head stock. We also fixed a chain on the chain collet as shown in above figure with help of flexibility of the collet. Now we will perform machining on the chain which was our final goal to achieve. The machining on the chain is shown in Fig 9.

There are few considerations of chain designing on CNC machine which are shown as below

- Tool used: 0.25 mm Engraving Diamond tip tool
- Feed rate: 0.1 mmpr
- Z axis feed rate: 5 mmpr
- Spindle speed: 60,000 rpm
- Depth of cut: 0.1mm
- Spindle used: vertical spindle



Fig – 9 machining on the chain

3.2 FINAL RESULT

Finally after machining we got engraved chain which design is shown in below the groove thickness is 0.8 to 1 mm. we used 0.25 mm Diamond tip engraving tool. The final design is shown in the below fig- 10. It is looking good and attractive. The main advantage of this research and development of chain collet is 1) fully atomization 2) detailed designing 3) multiple chains can be machined at a time by fixing it in different grooves of the pulley 4) machining time reduced. These are the most wanted points of expectations to the any machine. So, the design of chain collet solves many problems.



Fig – 10 Final product gold chain.

4. CONCLUSIONS

The advance machines like CNC have endless opportunity of expanding the utilization of computer aided manufacturing in this fastest growing industrial revolution. Till today we only utilize CNC machine in the jewelry for only designing on bangles and rings. After the development of the chain collet in this research paper, the way to design chains is now possible and it is now authenticated by experimental results that it is suitable to fix in CNC and it is proved by experiment that it is possible to machine a chain in CNC by utilizing of new design made of chain collet. So the whole procedure of designing or machining on chain is becomes easier, faster & accurate.

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