

## Design And Development Of An Assembly Fixture For Mounting A Circlip To The Piston

Prathap kairan\* and P.V. Srihari\*\*

\* M.Tech. (Tool Design) Student, \*\* Associate Professor

Department of Mechanical Engineering, R.V. College of Engineering, Bangalore-59

### ABSTRACT

Fixtures are the work holding devices utilized in industries for manufacturing, inspection and assembly operations. This paper describes about designing an assembling fixture for mounting circlip to the groove provided in the piston pin hole. After careful study of assembly components, a few concepts of fixtures were designed. Among these concepts the best concept is developed by using concept scoring technique. The detail design of the selected concept is done by using 3D software, Pro-E wildfire. Based on the detail design, 2D draft drawings are generated and supplied for manufacturing of the fixture. The implementation of the fixture is able to assemble 2160 number of pistons with the circlip in a day.

**Key words:** Assembly fixture, circlip, piston, fixture design.

### 1. INTRODUCTION

Fixture design consists of a number of distinct activities: fixture planning, fixture layout design and fixture element design. Fixture planning is to conceptualize a basic fixture configuration through analyzing all the available information regarding the material and geometry of the workpiece, operations required, processing equipment for the operations, and the operator. Fixture layout is a basic drawing of the concepts of fixture containing the primary needs of the fixture. Fixture element design is concerned with the complete details of the locators, clamps and supports. An output of fixture element design involves detail design of clamps, locators and supports

Different types of assembly fixtures are developed in order to perform various tasks. For rear hub assembly of different automobile vehicles a slide assembly fixture was developed [1]. Fixtures are also developed in order to assemble various components like piston rings in piston ring grooves, for assembling parts of multi part fuel pumps of automotive gas engine, for assembling automotive instrument panels, for assembling point contact devices such as transistors, for assembling electronic circuit modules and for assembly of fabricated rotor to the motors and generators [2-7].

The design of fixture for three fingered automated flexible fixture system to fixture planar objects in a machining process was developed [8]. By using 3D CAD/CAM software, design and assembly

of interference free modular fixture was developed [9].

In this paper an assembly fixture is designed for assembling circlip to the groove provided in the pin hole of a piston. The circlip constrains the movement of gudgeon pin or piston pin inside the pin hole. Due to the combustion inside the engine cylinder, a lot of energy is released. This energy is transferred from the piston to the crankshaft; Connecting rod connects the piston and the crankshaft like a linkage. The connecting rod converts reciprocating motion of piston into rotary motion of crankshaft, and transfers a lot of energy from piston to the crankshaft. In order to connect the piston and the connecting rod gudgeon pin or piston pin used. Due to the transfer of lot of energy through the piston there may be movement of gudgeon pin inside the pin hole, this may result in distortion. To prevent the movement of gudgeon pin inside the pin hole of a piston, circlips are used. Usually the diameter of the circlip is more than the pin hole diameter so the circlip should be compressed and installed.

### 2. CONCEPT GENERATION

Concept generation involves the identification of the requirements and new concepts are generated based on the requirements, the generated concepts are explained below:

#### 2.1 Concept 1

Concept 1 makes use of a mechanism which converts rotary motion into linear motion to push the circlip into the piston, a 3D model is shown in Fig.1. The mechanism mainly consists of a free wheel, linkage, push rod, guide block and a base plate. The push rod is connected to a wheel through the linkage. A handle is provided on the wheel to rotate the wheel, when the wheel is rotated by the operator, the linkage pushes the push rod to force the circlip into the piston. The circlip is guided through the guide block into the groove provided in the piston pin hole. The piston is located over the V-block with the pin hole axis of the piston over the locator provided in the V-block.

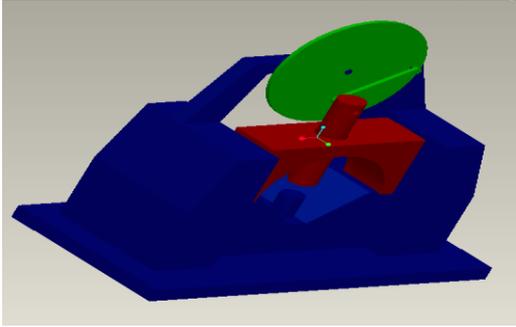


Figure 1 Concept 1

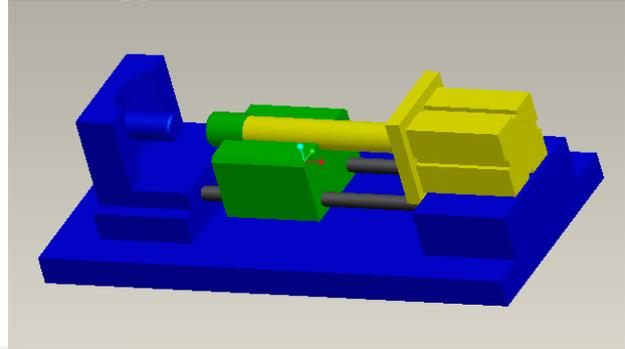


Figure 3 Concept 3

### 2.2 Concept 2

In this fixture concept, sliding mechanism is used to move the piston which is located on spring locator. The spring locator is clamped over housing, the housing is provided with a flange. This flange rides within the channel defined by the base. Piston is located over a spring locator, spring locators consists of spring loaded balls, there are two balls loaded with spring which locks with the pin holes provided in the piston. Once the piston is constrained, the locator is slid over the base plate towards the circlip mounting mechanism. On the other side of the base plate guide block is provided to load the circlip to the fixture. A push rod is used to push the circlip into piston. The 3D model of the concept 2 is shown in Fig.2.

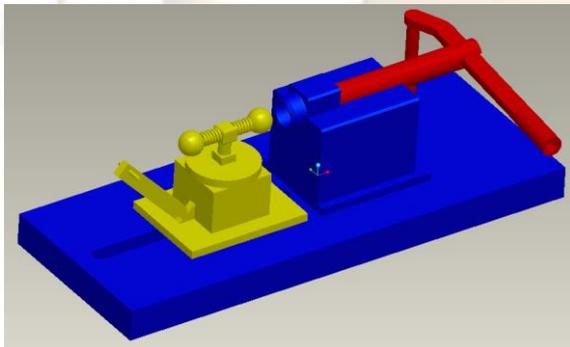


Figure 2 Concept 2

### 2.3 Concept 3

In this concept pneumatic cylinder is used to mount the circlip into the groove provided in the pin hole of piston. The whole concept contains base plate; there is housing on one end of the base plate. The piston is located on the housing; pin hole of piston is loaded over the locator provided on the housing. In order to insert circlip, a pneumatic cylinder is provided at the other end of the base plate. The cylinder pushes the push rod in order to push the circlip to the piston which is loaded over the guide block. A 3D model of the concept 3 is shown in Fig.3.

### 2.4 Concept 4

In this concept the piston is located on the profile locator, which arrests the movement of the piston and constrains it in all the directions. A hole is provided in the profile locator to allow the push rod to push the circlip into the groove provided in the piston pinhole. The circlip is loaded over the guide block and push rod pushes it forward to the piston. In order to support the push rod another support block is used. The push rod is operated manually. Push rod is connected to lever. The lever is pivoted at one end through the hinge and at the other end, handle is provided to operate the push rod. A 3D model of the concept 4 is shown in Fig.4.

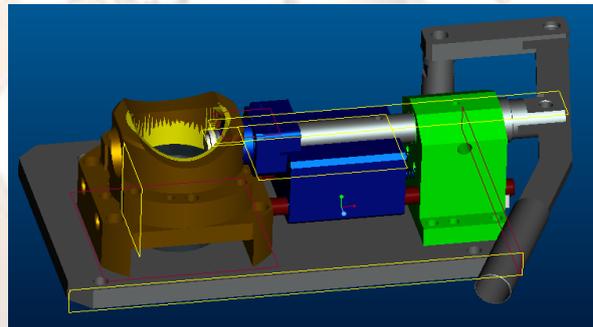


Figure 4 Concept 4

## 3. CONCEPT SELECTION

Concept selection is the process of evaluating concepts with respect to identified requirements and other criteria, comparing the relative strengths and weaknesses of the concepts, and selecting one or more concepts for further investigation, testing, or development. Concept selection method is carried out by *concept scoring* matrix. It is supported by decision matrices which is used by the team to rate, rank, and select the best concept.

Concept scoring is careful analysis of a relatively small number of concepts in order to choose the single best option.

The steps in concept screening and concept scoring involve: Preparing the selection matrix. Next step is to rate and rank the concepts.

Combine and improve the rated concepts. Finally, Select one or more concepts. Reflect on the

results and the process. Concept scoring process is shown in Table 1. for the fixture is selected. Concept 4 is the best concept as it is rated highest score in the matrix.

Using the concept scoring matrix the best concept

		Concepts							
		Concept 1		Concept 2		Concept 3		Concept 4	
Selection criteria(Easiness)	Weightage	Rating	W.S	Rating	W.S	Rating	W.S	Rating	W.S
Assembly of workpiece	45%	4	1.8	5	2.25	4	1.8	5	2.25
Manufacturing	10%	1	0.1	2	0.2	1	0.1	2	0.2
Assembly of fixture	5%	2	0.1	2	0.1	2	0.1	2	0.1
Alignment	5%	4	0.2	4	0.2	4	0.2	5	0.25
Handling	5%	2	0.1	4	0.2	2	0.1	3	0.15
Durability	5%	3	0.15	2	0.1	4	0.2	4	0.2
Cycle time	15%	4	0.6	4	0.6	4	0.6	4	0.6
Damages to workpiece	10%	2	0.2	4	0.4	3	0.3	4	0.4
	Total Score	3.25		4.05		3.4		4.15	
	Rank	4		2		3		1	
	Continue?	No		Yes		No		Yes	

Table 1 Concept scoring matrix for concept 1, 2, 3 & 4

#### 4. DETAIL DESIGN

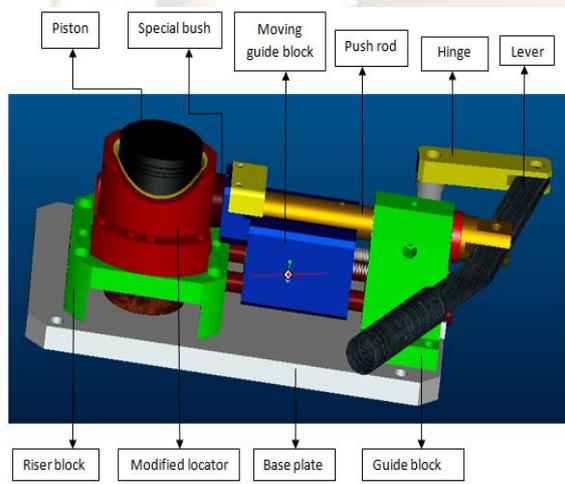


Figure 5: Fixture for assembling circlip and piston.

##### 4.1 Components of Fixture

The fixture consists of different parts in order to perform the assembly operation. The components of the fixture are explained in below section.

4.1.1 Base plate: Base plate is the base for all the components used in the fixture, all the components in the fixture are assembled over the base plate. Base plate should be strong enough to withstand the load of all the components.

4.1.2 Piston rest: Piston rest acts as a support for piston in the fixture. Piston (work piece) is located on the piston rest while assembling circlip to the piston.

Piston rest contains poka yoke in order to prevent wrong loading of the fixture.

4.1.3 Riser block: The main purpose of the riser block is to locate the guide rods. On the riser block modified locator is situated. Riser block is also a part of locating system.

4.1.4 Modified locator: Modified locator is a type of profile locator which arrests the movement of the piston during the assembly of the circlip. In order to prevent the damages to the piston during loading and unloading to the fixture, a Teflon piece is provided inside the locator.

4.1.5 Guide block: The guide block guides and supports the movement of push rod while assembling circlip to the piston. Guide block also provides housing for the guide rods which is connected to riser block. In order to prevent the wear caused by the movement of the push rod a bronze bush is provided inside the guide block.

4.1.6 Push rod assembly: The push rod is used to push the circlip into the piston. The push rod is connected to handle through the lever assembly. A pin is provided at the front of the push rod which makes contact with circlip.

4.1.7 Guide block: This guide block rests on the guide rods and it is made to slide on the guide rods. The movement of the guide block is required because this movement allows the special bush to reach up to the groove provided inside the pin hole of pistons.

4.1.8 Special bush: Special bush is installed at the front of the guide block, when the push rod pushes the

circlip through this bush, the circlip is compressed to diameter which is lesser than pin hole diameter.

4.1.9 Protector: Protector is above the guide block, as the push rod pushes the circlip it is compressed and circlip may fall from guide block, in order to prevent this protector is used.

4.1.10 Guide rods: Guide rods support the moving guide block. On the guide rods the block slides with the push rod. There are two guide rods.

4.1.11 Lever assembly: Lever is assembled to the rear end of push rod which is used to move the push rod through the guide block. Lever is provided with the handle at one end and the other end is pivoted to the hinge pin through the hinge.

4.1.12 Hinge and hinge pin: Hinge is connected between lever and hinge pin. The hinge pin is fixed and the lever is movable according to the operator direction. Hinge have two holes one to assemble over the hinge pin and the other to assemble with the lever.

4.1.13 Compression spring: Compression spring is inserted at the rear of the moving guide block which stops the motion above certain point.

[5] John B. Gray 3 and William R. Yeich, Assembly Fixture, *United States patent, Patent No. 2801329*, (1957).

[6] Arthur Richard Baker Jr., Fixture for assembling electronic circuit modules, *United States patent, Patent No.5732462*, (1998).

[7] William P Pizzichil, Fabricated rotor assembly fixture and method, *United States patent, Patent No.2007/0062026A1*, (2007).

[8] Hong Du and Grier C.I. Lin, Development of an automated flexible fixture for planar objects, *Journal of Robotics and Computer-Integrated Manufacturing 14*, (1998), 173-183.

[9] A.Senthil Kumar, J.Y.H.Fuh, T.S.Kwo, An automated design and assembly of interference-free modular fixture setup, *Computer-Aided Design 32*, (2000), 583-596.

## 5. COST ESTIMATION

The actual cost incurred to manufacture a fixture is defined as the cost estimation. The total cost of the fixture is defined in Table 2.

Table 2 Total Cost of the Fixture

Sl. No.	Description	Cost in Rs.
1.	Material	7317.78
2.	Manufacturing	24260
3.	Assembly	1200
4.	Inspection	1000
Total		33777.78

## 6. CONCLUSION

The implementation of the fixture is able to assemble 2160 number of pistons with the circlip in a day. The total cycle time to install circlip into piston is 33 seconds. This fixture prevents the damages on the piston during assembly. The effort of the operator is also reduced.

## REFERENCES

- [1] Meridith Grimsley and Birmingham, Slide assembly fixture for rear hub assembly, *United States patent, Patent No. 7225516*, (2007).
- [2] Frank M Prucha and Birmingham, Ring assembly fixture, *United States patent, Patent No. 2865091*, (1958).
- [3] William Hunter, Upland, Gerard A Naab and Morton, Assembly and test fixture, *United States patent, Patent No. 160394*, (1964).
- [4] Shalette Farmer, Instrument panel assembly fixture, *United States patent, Patent No. 2010/00450651A1*, (2010).