

Design and Fabrication Jig and Fixture for Pin Component in Vehicle Component Parts

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Abstract

In manufacturing industry especially automotive industry there are rising issues concerning the need to save labour energy, time as well as providing a lower cost industry. This paper presents the capability of 3D software to assist in generating and improving innovative product. This project helps the mechanics to remove pin component; distributor pin and piston pin. The issue here is with conventional method where the pin is removed by a punch method is too big of a risk on distributors or piston to accept the load from hammer. This project also hopes to avoid human injuries and reduce human energy when knocking the pin. Overall this project through three main phases, first design the jig and fixture using pro engineer software (Pro/E), second is in the fabrication process via machining process and finally analysis process by comparing outcome the distributor and piston in conventional method and using jig. The result shows that the function of jig and fixture reduces the damage on distributor and piston area.

Keywords: 3D software, automotive industry, distributor drive pin, piston pin, jig and fixture.

1. Introduction

A distributor is one of the main parts of automobile. This device located in the ignition system of an internal combustion engine that routes high voltage from the ignition coil to the spark plugs in the correct firing order. Distributor drive pin is located between the shaft and collar. Function of this pin is to make connection between distributor and gear shaft. In conventional method the pin punch used to remove this pin. This method is not practical to use because the pin and surface area are not able to withstand the load and the movement of pin is misaligned (parallel) and can cause damage (bend) to the shaft and damage the gear when the pin is driven out. The same situation applies to remove piston pin. A piston pin or wrist pin is a hardened steel pin which connects an engine's piston to a connecting rod. This piston pin is normally designed with pressed fit

method. This pin is being pressed into the connecting rod where adhesive wears are formed between two contacting surfaces. Failure to locate the pin smoothly will cause an engine suffering from detonation (pre-ignition) can also contribute to failure, broken connecting rods and even a broken engine block.

The pin punch technique not only damages the component but this method also can cause injuries to users especially the mechanic. Fingers and hands can be smashed due to misusing hammers. Hammers are basic tools but hammers are also recognized for causing thumb and finger injuries. It is estimated that some 50,000 Americans seek treatment every year as a result of a hammer injury.

To overcome this situation and to do job more precisely, accuracy, repeatability and safely and minimize the possibility of human error, a jig is designed based on product design development concept. This project aims to obtain an innovative product that can be defined as a new product that will become an innovation with enhanced quality and improve its overall performance. It is the branch of engineering that involves the design along with tools like computer-aided design and Pro/engineer to design and analyze and operation of machinery.

2. Product Design and Fabrication

Factors that have to be considered before starting the designing process is the need to identify and determine the problem of pin component (distributor pin and piston pin) issue if not maintained correctly. From this issue one mechanism is achieved by developing a jig. The proposed fixture will not only provide the repeatability and high productivity, but also offer a solution, which reduces work piece distortion due to clamping and machining forces [1]. With this jig, maintenance process becomes easier and safe for the component and mechanic. The information from experts in automotive and few mechanics must be taken into account in developing this jig. However,

there is a need to address the faster response and shorter lead-time required in designing and constructing new fixtures [2].

Every workholder variation has basic similarities to other types and styles of jigs and fixtures. For making jig and fixtures, discover the fundamentals of jigs and fixtures and works through the various elements and considerations of design [3]. The elements of jig are actually based on clamping devices concept. The most common example is bench vice. The purpose of producing the jig is to exert a force on the work piece (pin) and press a pin aligned with the locating surfaces and hold it in correct position of the location in the cutting forces. Jig is usually lighter in construction and it reduces or sometimes eliminates the efforts of marking, measuring and setting of work piece on a machine and maintains the accuracy of performance [4]. The nature of jig is to minimize the possibility of human error, minimize tool breakage, reduce manufacturing time and allow the use of less skilled people.

The designing process will use Pro/ENGINEER Wildfire 5.0 software to make 3D view of the project. The product will be designed with explode and assembly views to get the approximate dimension of the actual parts. The 3D model is also used to guess the best fitting for product assembly. Richard F. Riesenfeld et. Al., informed that, for many designers a significantly more contemporary and effective engineering approach and process would naturally ensue from the availability of advanced tools conducive to a process leading to better, more reliably correct, robust, much earlier trade-off explorations [5]. The design concept must base on the ability to solve the problem and always the simplest possible working solution. The combination of art, science and technology is needed to create new design of product. Good design is not just what looks good. It also needs to perform and fulfill its purpose. It can be innovative or it might just get the job done. There is a need to address the faster response and shorter lead-time required in designing and constructing new fixtures [6]. Kinematic analysis is used to determine whether a part creation is able to precisely locate and offer complete constraint to a product. According to the Necmettin Kaya, the optimization of support, locator and clamp locations is a critical problem to minimize the geometric error in product machining [7].

A decision matrix is used to evaluate the competing design concepts by ranking them with weighting factors and scoring the degree to which each design concept meets the criteria. The most commonly used approach to concept selection in engineering design practice. This method is typically used in the selection process at least in some form, if not used extensively [8]. It is a simple tool that can be very

useful in making complex decisions, especially in cases where there are many alternatives and many criteria to be considered. Thus it makes as a qualitative tool to evaluate the alternatives. It is important to keep old versions of the decision-matrix, to track the history of the design. In any product design process, problems arisen and past experience may play a crucial role, to help find a solution in less time [9].

For the machining process, most parts are made using conventional and CNC machine. The square part like clamp blocks (upper block and lower block) and base plate are produced by milling machine. The cylindrical part like T - rod, screw pin and pin produce by lathe machine. A finish part will be assembled and certain part need a precision dimension in joining process.

Product locating and clamping (vice) area are the crucial elements of any workholder or jig system. In selecting the supporting element and bases, consideration is given to the size of the workpiece, estimated space allocated to the clamping and locating elements and the type of machine tools to be used. The structure of the supporting element must be strong enough to absorb cutting, clamping and other inertia, gravitational forces which may be associated with the operation [10]. The basic principles of locating and clamping function need to be identified. The references of the product and the work area (jig pin) must be considered and simultaneously maintained in the design of a jig. To ensure the jig works correctly, clamping area must accurately and consistently place the product parallel to the jig pin. Clamping device should be incorporated into the fixtures, proper clamping in a fixture directly influences the accuracy and quality of the product and production cycle time [11]. At the same time the locators are used to ensure the product is located properly in static position, repeatable process and simultaneously maintained. The locators should be placed hard enough to hold the position of the product and to withstand the forces. The pin for distributor and piston cannot move out correctly if a product placed incorrectly, at the same time can cause scratch on product surface and pin area.

There are three general forms of location: plane, concentric, and radial. Plane locators locate a product from any of its external surfaces. Flat, curved, or have an irregular contour is example for plane surface. For Concentric locators, the product will be located from a central axis. For example locating jig pin placed in a pin hole of product. Certain product might have a cylindrical profile, this require a locating hole in the fixture. The third type of location is radial. Radial locators restrict the movement of a product around a concentric locator. This three general form of location also can be used as a combination method at the one jig and fixtures. For this jig the concentric

locator is suitable to used base on locator pin and product pin location.

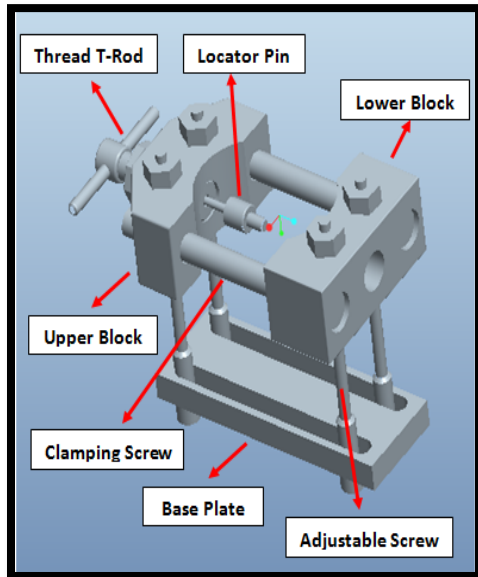
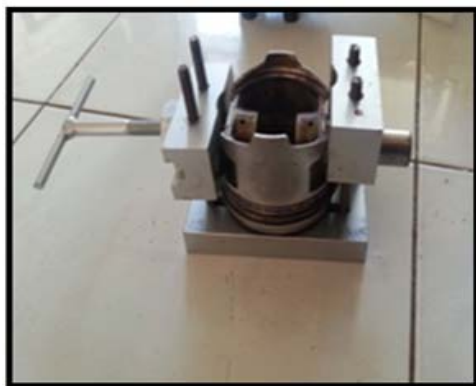


Fig. 1 jig and fixtures 3D view



(a)



(b)

Fig. 2. : (a) Process removal distributor pin using a jig. (b) Process removal piston pin using a jig and fixtures

3. Result and Discussion

3.1 Jigs Analysis

This process is to analyze the function and result of the jigs. The result analysis will be compared against conventional method. This process is repeated numerous times to check their consistency and precision. The jig should be capable in pressing the pin without leaving marks or scratches on the pin and the product’s body.

3.1.1. Surface Analysis on Distributor

Table 1: Experiment performed using jig and conventional method on car distributor

Method	Part	No. of try				
		1	2	3	4	5
Conventional	Pin	NO	NO	NO	NO	NO
	Body	NO	NO	NO	NO	NO
Jig	Pin	OK	OK	OK	OK	OK
	Body	OK	OK	OK	OK	OK

3.1.2. Surface Analysis on Piston

Table 2: Experiment performed using jig and conventional method on piston

Method	Part	No. of try				
		1	2	3	4	5
Conventional	Pin	NO	NO	NO	NO	NO
	Body	NO	NO	NO	NO	NO
Jig	Pin	OK	OK	OK	OK	OK
	Body	OK	OK	OK	OK	OK

Table 1 and 2 show the jigs aided users’ task to become more comfortable. It eliminated the efforts of putting pressure on body and pin at the same time jigs maintained their accuracy of performance. The product cycle time can be reduced when working with jigs as the product is quietly positioned at their point before the operation without the need for setting or aligning the product and tool first. This jig can also maintain a consistent quality of product which means the pin can be used repeatedly without it leaving any kinds of defect on the product’s body. This situation is the economical way to produce in mass production which would result in products with variability of dimension. The assembly operation becomes easy, facing low rejection due to less defective production is observed.

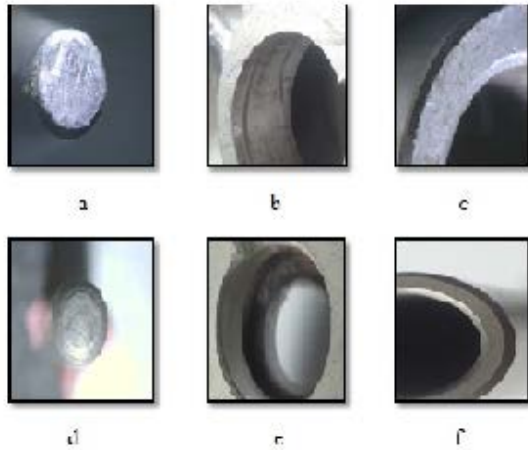


Fig. 3: a. b. c.: show surface scratch process done by conventional method (a. distributor pin, b. piston, c. piston pin). d. e. f.: show surface is maintained when using jig (a. distributor pin b. piston c. piston pin).

4. Recommendation

The following recommendations can be drawn based on the experimental results in this project.

- i) Improvements to this experiment can be done by changing the different materials type of locator pin. From here the ability of pin can be evaluated with the material surface.
- ii) The use of software tool for analysis can be improved in development and implementation to optimize certain aspects of assembly tooling design, especially force analysis. From this analysis the result can show whether the forces applied by the jig and clamping are sufficient or not before the jig is made. Some adjustment can be done on drawing.

5. Conclusion

This project designs and fabricates the feasibility of utilizing jigs component as an alternative method to assemble and dismantle pin component focus on distributor and piston part. It can be concluded from the project that the jig has shown improved as a replacement for the conventional method by hammering. This innovative mechanize jig gives some advantages with regards to safety and most importantly, it is less time consuming.

People, especially mechanic will benefit most from the performance of this jig for assemble and removal compared to conventional process in terms of accuracy and repeatability. It can also be used as a portable press machine.

Understanding jig and fixture mechanize offers economical way to produce a specific product

especially in mass production system. The jig component can be used and served with pneumatic or hydraulic system as power driven. This is easily controlled, consistent and results in quick operation.

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