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Fabrication of hydraulic press machine for mounting and dismounting rolling bearing

Abdul Rahman[1]*, Achmad Irianto [1], Nelson Manurung[1], Nursuar [1], Joni Indra [1] , Sumartono [1]

[1] *Dept. Mechanical State Polytechnic of Medan, INDONESIA*
**corresponding author: rahman@polmed.ac.id*

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ABSTRACT

Maintenance and Repair Workshop is an important facility to prepare and introduce students majoring in the maintenance and repair to industrial machines and equipment and system performance tests. A frequent complaint from workshop is that the price of the press machine is too high and only has one function, therefore not many workshops possess a press machine. Bearing is one of the engine components supporting the rotating shaft which serves to reduce the friction that occurs between the rotating and fixed machine parts. Damage to the bearing is caused by several factors, one of them is an error that occurred when mounting and dismounting the bearing of the shaft. Based on the experience that 16% of premature bearing failures are due to mounting errors. It often happens that technicians install the bearing on the shaft in a rough way, such as hitting the bearing with a hammer or using a welding flame to expand the inner ring of the bearing so that it is easily inserted into the shaft. This will damage the bearing and its position is no longer precise, resulting in unstable shaft rotation. Using the correct equipment and bearing installation methods will save on bearing replacements. The purpose of this research is to make a bearing mounting and dismounting equipment using a press machine driven by a hydraulic system with maximum pressure is 3 tons. This pressure is generated by a hydraulic jack which presses the inner bearing into the shaft bearing for mounting bearing and into the shaft for dismounting bearing with a predetermined force. The research methodology includes construction planning which consists of construction and element design, analyzing design results, select alternative designs, draw elements and construction according to the selection of alternatives and fabrication by mean of machines toll and welding. From the tests carried out, the press machine has an efficiency of 90%, and the time for mounting and dismounting bearings is 30-50 seconds depending on the size of the bearing. The equipment can be used for practical tools in the maintenance and repair workshop and other purposes in a mechanical workshop, similar as a pressing used drink cans for recycling.

1. Introduction

The development of technology is very rapid in the field of Mechanical Engineering and the problems faced are increasingly complex. On the other hand, the handling of work must be carried out efficiently and effectively to obtain optimal and satisfactory results. One of the activities involved in mechanical engineering work is installing and removing bearings. Bearing is a machine element that serves to reduce the friction that occurs between the rotating machine parts and the stationary ones. Bearings are used in machinery to keep moving parts accurately positioned to limit wear and to allow easy movement with little friction. Usually, the movement is rotational: either a shaft turns inside the bearing, or the bearing rotates around a shaft. In some cases, the movement may be linear, with the shaft moving endways through the bearing. Bearings used in a particular application must be able to handle the kind of machine movement involved (Lionel Owen, 1992).

Now a day's hydraulic system plays very important role in almost all the application. As in automobile industries, small service center, aircraft industries and used where precision is required. Traditional method of bearing removal or installation is hammering, but unnecessary hammering causes several problems. The unsafe and excessive hammering cause's damage of bearing surface or sometimes chance to failure and excessive human effort required. In order to remove or installed bearing safely, is to make modification in traditional method. The purpose of modification required less human effort, simplicity of operation, removing and installing bearing done without damaging bearing surface, compact, portable and well suited. The hydraulic bearing puller based on hydraulic system on the principle of Pascal's law which states that " Pressure distribution in enclosed cylinder is uniform in all direction (Suryawanshi *et al.*, 2015).

Problem experienced by technicians when dismounting bearings from irregular shafts is they had difficulty in removing bearings from the shafts. When dismounting bearing from the shaft, usually is being done by hitting the bearing using a plate or chisel. This method may speed up the working time, however it is not safe and may occur damage to the shaft and bearing. Damage often occurs when mounting and dismounting bearing because technicians do it manually and roughly, such as hitting the bearing with a hammer directly on the bearing and using a welding to enlarge the bearing's inner ring so that it is easily inserted into the shaft (Smith, 2008).

Manual mounting and dismounting bearing on shafts are limited to a bearing shaft size of 60 mm. For the shaft sizes or bearing inner diameters above 60 mm, mounting and dismounting of bearings requires special equipment such as a hydraulic press to press the shaft apart from the bearing and press the inner ring of the bearing during installation. Based on the experience that 16% of premature bearing failures are due to installation errors. By using the correct equipment and bearing installation methods, it will be able to save on bearing replacements (Smith, 2008). This study aims to make a bearing mounting and dismounting equipment with a capacity of 3 tons, especially for medium and large-sized bearings with a hydraulic press system.

2 Literature review

2.1 Mounting and dismounting rolling Bearings

Bearing vary greatly in type and size there is no universally applicable mounting method. With non-separable bearings the forces must be applied directly to the ring which is being fitted. If the mounting force act on the outer ring, e. g. when mounting the inner, the rolling elements must transfer the mounting force. Damage to raceways and rolling elements is likely to result. (Georg Schafer, 1991).

2.1.1 Mounting of small bearings

For small bearings fitting with a press is widely used. Small bearings with a loose fit may be driven on the shaft with a mounting sleeve or with a tube. The mounting sleeve is placed on the inner ring of the bearing and then gently squeezed until the side of the inner ring rests against the shoulder of the inner ring shaft as shown in Fig. 1. The inside diameter of this sleeve needs only be a little larger than the bearing bore. The outside diameter should not exceed the inner ring shoulder height to avoid damage to the cage. The mounting sleeve must be placed on the inner ring not on the outer ring for press mounting, since the bearing may be damaged. Applying oil before mounting to the fitted shaft surface is recommended for smooth insertion. The mounting method using a hammer should only be used for small ball bearings with minimally tight fits and when a press is not available. If any time uses a hammer, the mounting tool must be placed on the inner ring (Jeffrey, 2011)

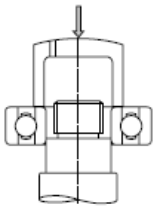

Figure 1. Press Fitting Inner Ring (extracted from www.omesin.com)

When both the inner and outer rings of non-separable bearings, such as deep groove ball bearings, require tight-fit the mounting tool is placed on both rings as shown in Fig. 2, and both rings are fitted at the same time using a screw or hydraulic press. Since the outer ring of self-aligning ball bearings may deflect a mounting tool such as that shown in Fig. 2 should always be used for mounting them. If the bearing has to be pressed onto the shaft and pushed into the housing at the same time, a shim should be used which bears against both bearing rings (Stolarski, 2000)

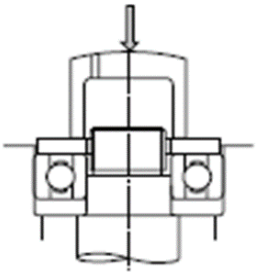

Figure. 2 Press Fitting of Inner Ring and Outer Ring (www.omesin.com)

2.1.2 Several tools are used to remove and install bearings:

1. A puller with a screw pusher,

This special tool can be adjusted to fit behind the bearing cone. The universal puller kit also includes many fittings and adapters to suit a variety of jobs. Many fittings and adapters are also included in the universal puller kit.

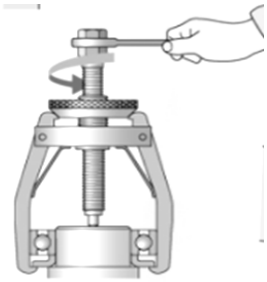

Figure 3. Dismounting with puller (extracted from omesin.com)

2. Hydraulic pressure

In the hydraulic press operation to remove the bearing from the shaft, place the support just under the inner race of the bearing. Increase the pressure on the shaft until the bearing and shaft separate. Make sure the shaft is in line with the press to ensure that the shaft is not thrown due to misalignment.

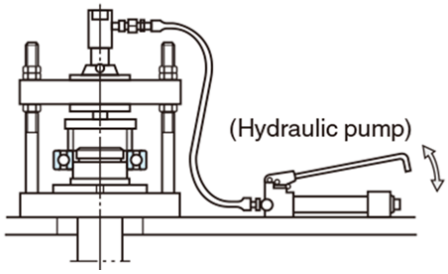

Figure 4. Dismounting with the manual hydraulic press (https://www.schaeffler.com)

2.2. Dismounting bearing

There are several methods of removing the rolling bearing, depending on the press fit setting made during installation. The method most often used is to remove the rolling bearing on the shaft by using a puller/ puller/ tracker. There are several ways to remove the rolling bearing;

2.2.1. Dismounting with a hammer and drift

A mild steel drift (or punch) and a hammer are often occupied to knock the bearing out of the housing. During the operation, listen for the change in sound when the bearing is securely attached to the shaft or housing. Hitting excessively when the bearings are properly installed may damage the inner race. Be careful not to damage the bearing race when installing using a drift.

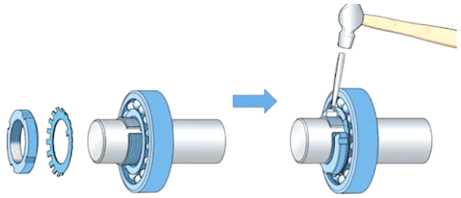

Figure 5. Dismounting with a hammer and drift (www.omesin.com)

2.2.2. Dismounting with pressing

In this case the bearing is removed by pushing the shaft. The inner ring is given a retainer first then the shaft is pushed or hit, the pushing process can be with a hammer or the help of hydraulics.

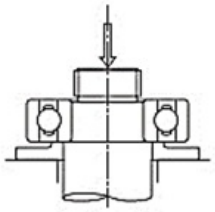

Figure 6. Dismounting with pressing (www.omesin.com)

2.2.3 Dismounting with Heater and freezer

When the bearing using a heater with the aim that expands and can be installed easily on the shaft. The freeze makes the shaft shrink, as a result so that it can be installed in the housing. The heating method is too hot for the bearing, all parts of the bearing are heated, and contamination of the bearing. As a result, the heating step can change the composition of the bearing iron and damage parts of the bearing cage that are not prepared to withstand high temperatures. In the end the bearing life will be shorter.

For the correct way of heating, create a heating device that uses electromagnetic induction power – Induction Heater. The tool will only heat the inner ring bearing with a controlled temperature (not exceeding 130 degrees Celsius). After the bearing is heated by electromagnetic induction, the tool will also remove the magnetic element from the bearing as well to maintain the integrity of the bearing composition. Once finished heating, the bearing stays inserted into the axle easily in a short time (Rudney *et al.,* 2017)

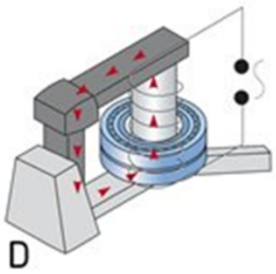

Figure 5. Heating bearings using electromagnetic induction (https://www.kogelahar.com)

3.0. Methodology

3.1. *Research Flowchart*

The flow chart of this research is shown in Figure 6 below.

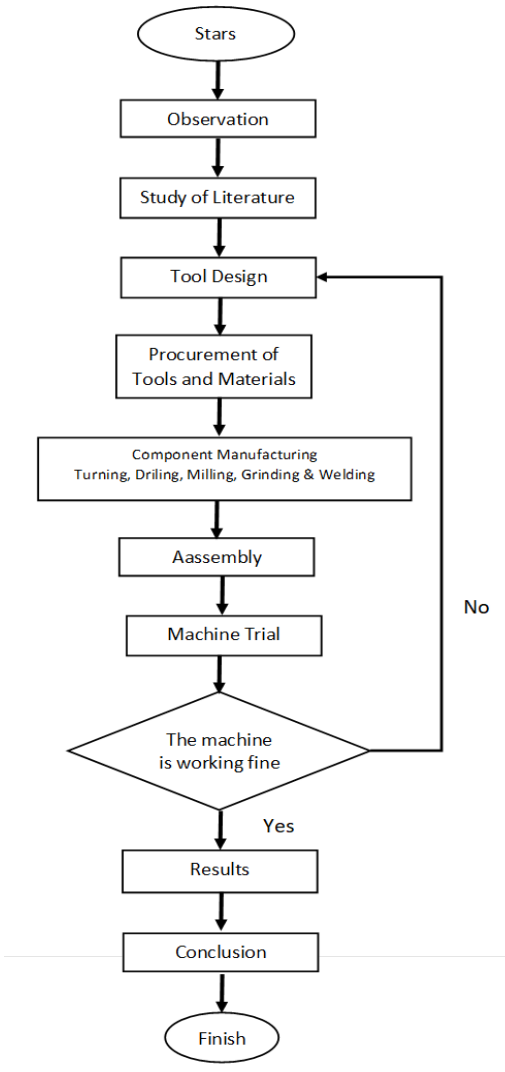

Figure 6. Research Flowchart

3.2 Design Concept of Press Machine

The design of the press machine is shown in figure 7 below.

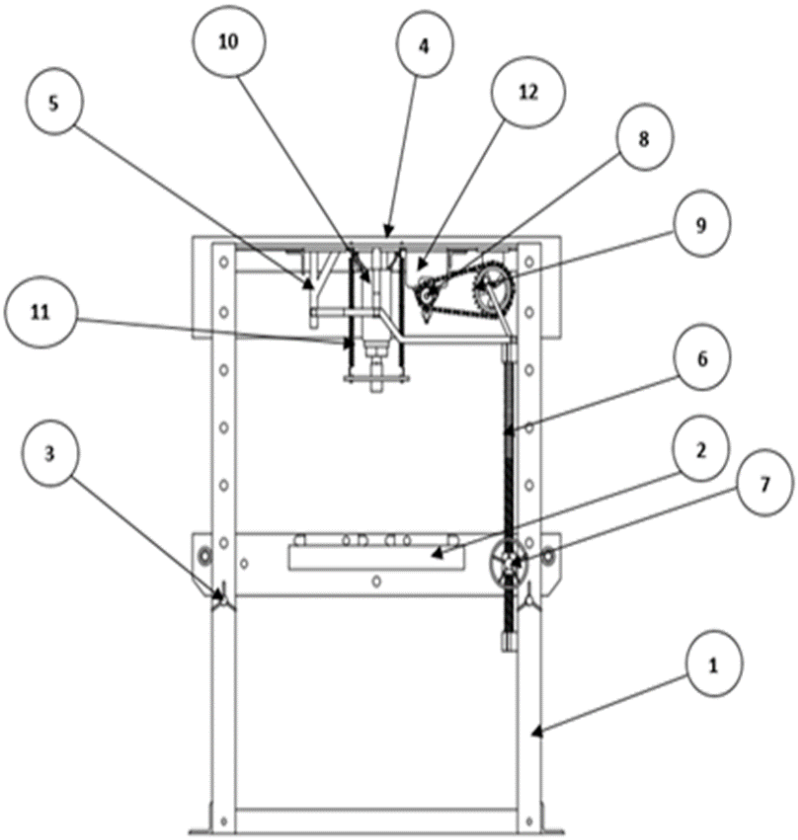

Figure 7. Design of press machine

Parts Name :

1. Frame
2. Bottom Platform
3. Bottom Platform
4. Top Platform
5. Jack lever
6. Shaft Adjustment Thread
7. Threaded Lever
8. Dynamo Sprocket
9. Hydraulic Jack Sprocket
10. Dynamo Stater
11. Spring Press
12. Hydraulic Jack

3.3 Design Parts of Hydraulic Press Machine

3.3.1 Frame

The frame is a part of the press machine that functions as a holder for other components. The engine frame is made with a size of 1048 mm x 1230 mm and made of angled steel 65x 65 mm with a plate thickness of 6 mm. The engine frame is assembled with welded joints and bolted joints.

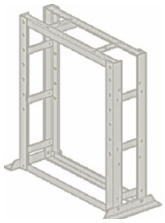

Figure 9. Machine Frame

3.3.2 Bottom Platform

The bottom base serves to support the bearing that will be pressed and rearranged its position to keep it parallel to the object's position. The bottom base size is 910 mm x 210 mm x 130 mm.

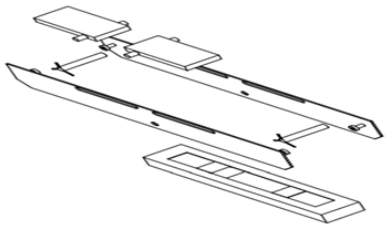

Figure 10. Bottom Platform

3.3.3 Top Platform

The upper base serves as a support t when the hydraulic jack works down to press bearing. The upper base is made with a size of 912 mm x 212 mm x 50 mm, made of steel with 10 mm thickness.

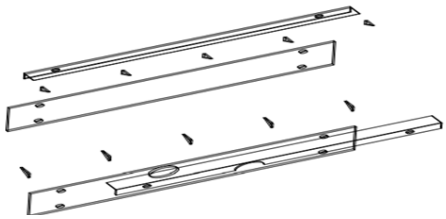

Figure 11. Top Platform

3.3.4. Jack Actuated Lever

The jack lever work from a rotary motion converted into a translational motion through a sprocket connected to a hydraulic jack actuator lever. The sprocket is made of steel plate material and is able to withstand strong loads or moments because the crank gear must accept high speed.

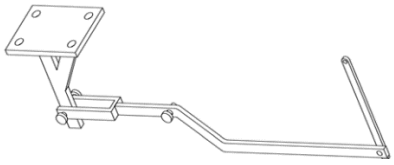

Figure 12. Jack Lever

3.3.5 Shaft adjustment thread

The shaft adjustment thread serves as a retainer and drives the bottom base of the machine up and down in a certain position as needed. The thread is made of mild steel material with a size of M 20 x 560 (mm). By using this thread, the position of the bearing or object to be pressed can be adjusted to a certain position as needed, because the thread has a movement movement step along the threaded shaft.

Figure13. Shaft Adjustment Thread

3.3.5 Hydraulic jack

The hydraulic jack serves to lift the load or as a compressive force. The pedestal hydraulic jack relies on fluid fluids. When the fluid in the tube is pushed, the fluid will then push the hydraulic cylinder continuously according to the motion received.

Figure 14. Hydraulic Jack

3.3.6 Spring Press

The pressing spring serves to maintain the position of the disc, return the jack to its initial position, and provide a compressive force on the disc of the bearing shaft press.

3.3.7 Dynamo starter

The dynamo starter functions to rotate the drive sprocket which is connected to the jack sprocket through the chain. The rotary motion of the sprocket is connected to the jack lever. The rotation connected to the lever will be converted into a translational motion which will move the jack-up and down.

3.3.8 Fabrication Flowchart.

The flow chart of fabrication is shown in Figure 8 below.

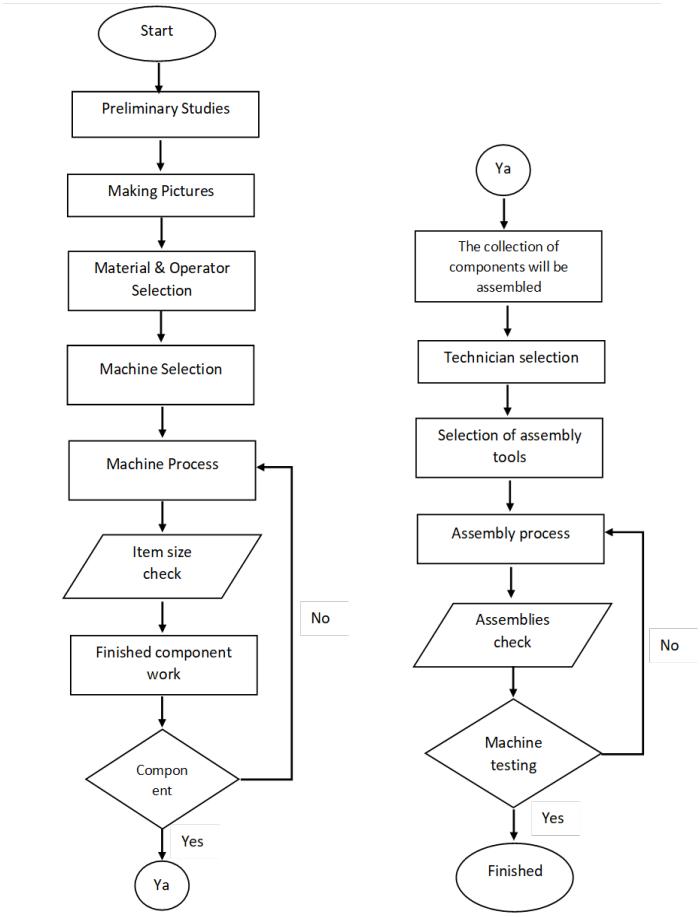

Figure 8. Flowchart Fabfrication

4. Discussion of analysis and findings

The result of this study for fabrication of press machine for bearing mounting and dismounting is seen in the below picture and details of components and materials as seen in table 1.

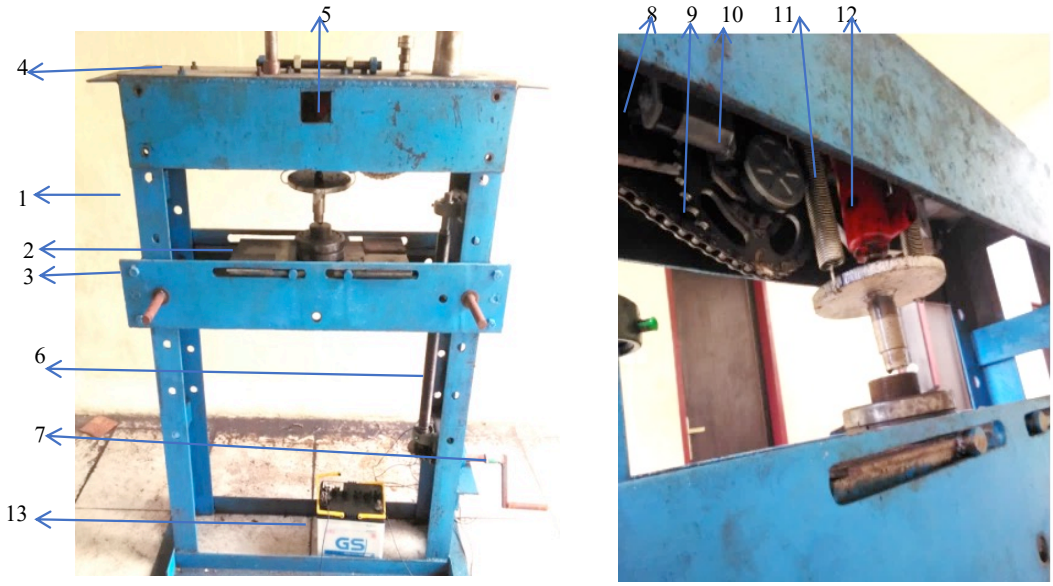

Figure 8. Hydraulic press machine

Table 1. Details of Components and Materials

No.	Components	Material
1	Frame	Mild Steel
2	Bottom Platform	Mild Steel
3	Bottom Support	Mild Steel
4	Top Platform	Mild Steel
5	Jack actuated lever	Mild Steel
6	adjustment thread	Mild Steel
7	Threaded Lever	Mild Steel
8	Drive Sprocket	Standard
9	Hydraulic Jack Sprocket	Steel Plate
10	Dynamo Stater	Standard
11	Spring Press	Steel Spring
12	Hydraulic Jack	Standard
13	12- volt battery	Standard

The machine works semi-automatically with up and down motion driven by a dynamo (10) from a rotary motion converted into a translational motion through a sprocket (9) connected to a hydraulic jack actuator lever. The power required to drive the dynamo is supplied from a 12-volt battery located at the bottom of the press machine.

4.1. Testing results

Machine testing was carried out three times with different types of bearings. The time required is the bearing setting time on the runway for position adjustment of the support pin with shaft position. Processing time is time pulling and pressing by the shaft on the bearing while the release time is the time it takes to move the bearing from the support. The press machine has an efficiency of 90%, and the time for mounting and dismounting bearings is 30-50 seconds depending on the size of the bearing.

5. Conclusion and future research

The method of mounting rolling bearings strongly affects their accuracy, life, and performance, so their mounting deserves careful attention. Their characteristics should first be thoroughly studied, and then they should be mounted in the proper manner. From the tests carried out, the press machine has an efficiency of 90%, and the time for mounting and dismounting bearings is 30-50 seconds depending on the size of the bearing. The equipment can be used for practical tools in the maintenance and repair workshop and other purposes in the mechanical workshops. Like pressing used drink cans for recycling. By using of this machine may increase operator comfort and safety when mounting and dismounting the bearings, especially for medium and large bearings.

Acknowledgment

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