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Bushing Puller and Installer

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***Abstract*—** This study aimed to design, fabricate, and evaluate a "bushing puller" and "installer" for automotive under-chassis bushings, comparing it to conventional methods in terms of performance, safety, and time efficiency. The device is designed to aid automotive mechanics in safely and conveniently pulling out and installing bushings. Key components include a hydraulic actuator-powered adapter that pushes or catches the bushing, a guide shaft for alignment, and a hydraulic pump supplying fluid pressure to the actuator. Testing demonstrated that the "bushing puller" and "installer" reduced the average bushing removal time to 10 minutes and 15 seconds, a 49% improvement over the conventional average of 20 minutes and 12 seconds. Installation time was similarly shortened, with an average of 6 minutes and 31 seconds compared to the conventional method's 16 minutes and 5 seconds, reflecting a 59%-time reduction. The hydraulic actuator, requiring minimal operator force at an average pressure of 150 psi, minimized the risk of injuries associated with manual or flame-based methods, which can damage the bushing housing or cause harm to the operator. The study concluded that the bushing puller and installer provided faster, safer, and more efficient bushing services compared to conventional practices. Recommendations by the technical evaluators included: (1) the gadget's enhanced efficiency in bushing removal and replacement, (2) improved safety throughout the servicing process, (3) reduced environmental impact by eliminating the need for burning, (4) successful alignment with design objectives, and (5) suitability for on-vehicle bushing replacement. This innovation addresses safety concerns and improves the servicing process by incorporating environmentally friendly mechanical methods.

***Keywords*—** Bush, Bushing, Extract or Pull Method, Install.

I. INTRODUCTION

A suspension system is adopted in an automobile to have a good and comfortable ride. The function of a car suspension is to maximize the friction between the tires and the road surface, provide steering stability with good handling and ensure the comfort of passengers.

Car bushings are small rubber or polyurethane suspension components that are used to isolate vibration, provide cushioning, and reduce friction between metal parts of your vehicle. The most common car bushings are control arm bushings and sway bar bushings, but you will also find bushings positioned between your vehicle's suspension and frame in several other areas (Firestone Complete Auto Care, 2022).

Replacing defective bushings without appropriate tools is hard. Numerous Prior arts address the problem of replacing the bushing. One of these is invented by Floyd B. Jacks in titled "bushing extractor/installer". A bushing extractor/installer apparatus for extracting an existing bushing having an axial through the bore from a vehicular suspension spring and installing a replacement bushing therein. The apparatus comprises a threaded rod, a shell portion, and a pair of circular disks: one disk for extraction of the existing bushing, the other disk for installation of the replacement bushing. The threaded rod is slid ably sequentially inserted through a hydraulic ram having a through bore, the shell portion with a cavity thereof being directed toward the bushing to be extracted, the bushing, and the extraction disk. The shell portion being larger than the extraction disk is smaller than the spring opening containing the bushing, the ram, in cooperation with the threaded rod and the extraction disk, urges the bushing into the cavity of the shell portion. The threaded rod is then slid ably sequentially inserted through the hydraulic ram, the shell portion with the cavity thereof directed away from the bushing to be installed, the replacement bushing, the spring, and the installation disk. The installation disk is larger than and the replacement bushing is substantially the same size as the opening in the spring, the ram, in cooperation with the threaded rod and the installation disk, urges the replacement bushing into the spring opening, completing the installation of the replacement bushing therein (Floyd B. Jacks, 1991).

Another puller device invented by Paul C. Charron is a "Universal bushing tool and method of use. A universal bushing tool for removing bushings of various diameters from machine assemblies is disclosed. The present tool comprises a handle, a plurality of interchangeable handle extensions, a plurality of sets of interchangeable wedge segments, and a plurality of interchangeable pilot studs that are mechanically attached to the handle

extension. In a method of the present invention, a set of wedge segments is selected based on the diameter of the bushing to be removed. Next, a handle extension of an appropriate length is selected based on location and access to the bushing. Next, a pilot stud of appropriate diameter for the size of the wedge segments to be used for removing the bushing is selected. Thereafter, the wedge segments are arranged at 90° intervals about the pilot stud and captured between the pilot stud and the handle extension, and tightened retaining the wedge segments in a disc-shaped configuration (Paul C. Charron, 2007).

Another puller device invented by Warren A. Whitney and Robert W. Hanna, JR. is the "Bushing replacement kit". The bushing replacement kit includes components for reaming out a bushing passage in a mechanical structure, and for installing a new bushing in the passage. The reamer portion of the kit includes a reamer guide, which is secured precisely and immovably to the seal sleeve of the passage, the reamer having a pilot shaft that fits precisely within the guide. The guide is held in place by a guide retaining plate, which is clamped to the mechanical structure over the guide. When the reaming operation has been completed, the ream is removed and a threaded bushing installation shaft is passed through the guide and bushing passage. A new bushing is placed at the back of the passage, with a bushing installer placed at the back of the bushing. A threaded fastener is installed on the installation shaft and tightened to force the new bushing into its passage (Whitney, A. et al. 2012).

The three technologies above have a noble intention, but they have some disadvantages compared to the researcher's study. The three technologies above may not be able to pull out the bushing if the pushing is corroded. The puller may be able to damage its threaded part. In the researcher's study, he installed a hydraulic with a pressure gauge instead of a mechanical one. The hydraulic will push the bushing out on the housing through the force of fluid then the pressure gauge will measure the force applied by the hydraulic. Then the hydraulic will also insert the bushing into here housing.

II. OBJECTIVES

This study aimed to design, fabricate, and evaluate the "bushing puller" and "installer."

Specifically, this study aims to: (1) design and fabricate the bushing puller and installer and (2) evaluate the operating performance of the Bushing Puller and Installer as to (a.) Time (Removing and Installation) and (b.) Hydraulic pressure.

III. METHODOLOGY

Design Criteria

The study of bushing puller and installer was designed to pull out and install bushing under the chassis of an automobile. The chassis of automobiles have four systems, the chassis, suspension, brake, and steering system. Bushing used under chassis is used to reduce friction between two surfaces sliding against each other.

The bushing puller and installer make the work of mechanics fast and easy to remove the bushing under the chassis of the automotive vehicle.

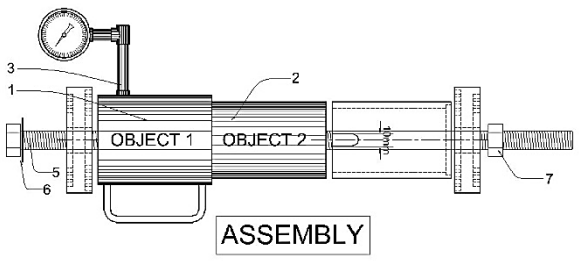
Design Plan Preparation

This study utilized the technological research method in designing and fabricating the Bushing Puller and installer. The intention of this innovation was based on the existing problems of the prior arts. The realization of these innovations has some complexity to the prior inventions which is the basis of conducting further innovations upon considering its usability.

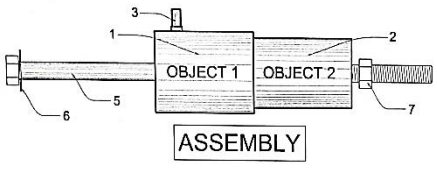
The assembly plan and design of the Bushing Puller and installer were evaluated thoroughly in relation to the features of the latest prior art to establish that it is feasible to innovate and add some features to the existing ones.

Proposed Bushing Puller and installer

The design plan and components parts of bushing puller and installer illustration of all components, as shown in Figures.



Perspective/ Isometric View of Bushing Puller



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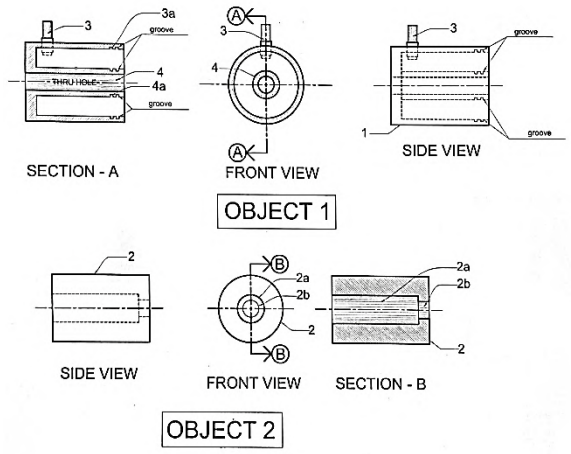

Components of hydraulic Actuator

Fabrication Procedure

The plan and design of the "bushing puller" and "installer" were reviewed first about the features of the latest prior art to identify and ensure that there is a possibility to develop or innovate some features in the existing one. The availability of the materials for the construction of the Bushing Puller was considered. The design plan preparation of the Bushing Puller and installer was prepared after the review of prior arts with the possibility to innovate and improve to minimize the problems.

In the process of gathering supplies and materials, the needs for parts of Bushing Puller and installer for construction and specified standard of materials for fabrication were considered.

Pilot Testing and Revision

After the gadget was constructed, pilot testing and revision were conducted together with the invited experts in the field for comment and suggestions. The researcher presented a short overview of the uses and features of the gadget to the invited experts. After a short presentation, the researcher demonstrated how to use the gadget. some comments and suggestions from the evaluator were noted for the improvement of the research study. From this point, the gadget was then subjected to revision of its design to meet the desired output.

The fabrication of the Bushing Puller was started by proper planning of design for all parts according to the functions.

Technical Evaluation Procedure

a. Technical Evaluation Procedure

The "bushing puller" and "installer" service tools after having been completed and ready to operate were subjected to technical evaluation which was conducted by selected technician experts from different fields of specialization at the Automotive Technology Shop of Iloilo Science and Technology University, La Paz, Iloilo City.

b. Test Evaluation Procedure

The Bushing Puller and installer were tested in different vehicle suspension bushings in (3) trials to evaluate the disassembly and assembly servicing time as compared to the conventional method.

The researcher used a Stopwatch during the evaluation. The stopwatch was used to measure the time spent in removing and installing bushing using the Bushing Puller and installer and Conventional Methods. The difference between the two (2) methods was determined by checking the time spent removing and installing bushings.

Instrumentation

To gather data needed for the study the researcher use the following equipment first the stopwatch used to measure the deference of time in using the "bushing puller and installer" and the conventional method, and second is a hydraulic gauge used to measure the operating hydraulic pressure of "bushing puller and installer", and third is the calculator use to solve percentage of the time difference between the "bushing puller and installer" and to the conventional method.

Parameters for Analysis

The following parameters for analysis were considered in the evaluation of the design, fabrication, and operating performance of the Bushing Puller and installer as compared to the conventional method:

Time. Time is the measured or measurable period during which an action, process, or condition exists or continues (Merriam-Webster, 2022).

The hydraulic pressure at any point within the fluid is the same in all directions provided of course that the fluid is static (Hi-Force, 2022).

IV. RESULTS AND DISCUSSION

Interpretation and Analysis of the Research Output

Data gathering was conducted during a series of tests on the function of the "bushing puller" and "installer" to

remove and installation of bushings in the vehicle. The result using the "bushing puller" and "installer" was compared with the result using the conventional method, using an appropriate statistical tool for the interpretation of the data.

Removal Time

One of the objectives of this study was to evaluate the performance of the "bushing puller" and "installer" on speed or the removal and installation time.

The average time difference in removing the under chassis bushing of Tamaraw FX was tested using the Bushing Puller and Installer and compared to conventional Methods in three (3) trials. This was to determine the percentage removal time difference and to show which method is faster.

Table 1. *present the evaluation of pulling out bushing using "bushing puller and installer" and the conventional method in terms of time.*

TRIALS	Conventional Method	Bushing Puller and Installer	Difference	Percentage of Difference (%)
1	20:15	10:48	09:27	47%
2	18:47	09:25	09:22	50%
3	21:35	10:33	11:02	51%
Average Time	20:12	10:15	09:57	49%

Data revealed that in three (3) trials, the bushing removal time adopting a Conventional Method of 20 minutes and 12 seconds was higher compared to using the Bushing Puller and Installer of 10 minutes and 15 seconds, having an average removal time difference of 9 minutes and 57 seconds, resulted to the percentage of 49% (percent). This implies that using a Bushing Puller and Installer in removing the Bushing was faster based on the time scale shown in the Table or 49% (percent) compared to adopting the Conventional Method.

It is implied that the "bushing puller and installer" will be a great help to the automotive mechanics because it would lessen their burden in pulling out of bushings and to the automotive instructor this would give them the idea of how to simplify their task in giving instruction.

Installation Time

One of the objectives of this study was to evaluate the functionality of applied pressure for bushing removal and installation using the Bushing Puller and Installer.

The average time difference in installing the bushing of Tamaraw FX was tested using the Bushing Puller and Installer compared to Conventional Methods in three (3) trials. This is to determine the percentage installation time difference and to show which method is faster as shown in table 2.

Table 2. *presents the evaluation of installing bushing using "bushing puller and installer" and the conventional method in terms of time.*

TRIALS	Conventional Method	Bushing Puller and Installer	Difference	Percentage of Difference (%)
1	15:12	06:12	09:00	59%
2	17:25	06:52	10:33	61%
3	15:37	06:30	09:07	58%
Average Time	16:05	06:31	09:33	59%

Data reveals that in three (3) trials, the average bushing installation time of Tamaraw FX using the conventional method of 16 minutes and 5 seconds was higher compared to using the Bushing Puller and Installer of 6

minutes and 31 seconds and having an average installation time difference of 9 minutes and 33 seconds which resulting to 59 percentage of difference. The result showed that the Bushing installation time using the Bushing Puller and Installer was faster at 59% (percent) than using the conventional method.

It is implied that the "bushing puller and installer" will be a great help to the automotive mechanics because it would lessen their burden in installing bushings and to the automotive instructor this would give them the idea of how to simplify their task in giving instruction.

Applied Hydraulic Pressure

Another objective of the study was to determine the efficiency of the applied hydraulic pressure in bushing removal and installation operation using the Bushing Puller and Installer.

Removal Operation

The hydraulic pressure applied in the bushing removal operation using Bushing Puller and Installer was determined as shown in Table 3.

Table 3. *present the applied Hydraulic pressure for Bushing removal operation using Bushing Puller and Installer.*

TRIALS	Applied Hydraulic Pressure In PSI
1	180psi
2	150psi
3	170psi
Average	166.67psi

Data shows in three (3) trials, the average applied hydraulic pressure in the bushing removal using the bushing puller and installer was 166.67psi. This shows that applied pressure was considered very minimal exerted by the automotive mechanic to remove the bushing using a busing puller and installer.

Installation Operation

The hydraulic pressure applied for the bushing installation operation using Bushing Puller and Installer was determined as shown in table 4.

Table 4. *present the applied Hydraulic Pressure for bushing using bushing puller and installer.*

TRIALS	Applied Hydraulic Pressure In PSI
1	130psi
2	120psi
3	150psi
Average	133.33psi

Data reveals that in three (3) trials, the average applied hydraulic pressure for the bushing installation operation using the bushing puller and installer was 133.33psi. This shows that the applied hydraulic pressure needed to install the bushing using the bushing puller and installer was very minimal.

Therefore, the Bushing Puller and Installer were found as a quicker and more suitable device for the automotive mechanic in removing and installation of bushing than using the conventional methods. Likewise, minimal applied hydraulic pressure is needed by the automotive mechanic to remove and install the bushing.

V. CONCLUSIONS AND RECOMMENDATIONS

From the foregoing findings, the following conclusions were drawn: (1) The servicing time in Removing and Installing of automobile under chassis using the Bushing Puller and installer is faster than adapting the conventional method.; (2) The Removing and Installing of automobiles under chassis procedure as operation in an automobile under chassis using the bushing Puller

and installer are faster and more convenient as compared to the conventional methods.; and (3) Safety on proper alignment of materials.

Based on the findings study, the following recommendations are offered: (1) The industry of automobiles or users of Bushing Puller and installers must appreciate the innovation and the familiar with its operating procedures. Specifically, operators should align all parts of the gadget and operators must look for the perfect bushing. Proper procedure and setup of Bushing Puller and installer during removal and installation of Bushing must also be followed.; (2) The actual situations adopted in the operation procedure of Under Chassis Bushing Removal using the conventional method that usually burns the rubber and hummer the outer shell of the bushing or brings the under-chassis parts to the machine presser nearby. This is to motivate the students or trainees to further create useful projects and appreciate their usage in the future.; and (3) The improvement in the servicing time during removal and installation using the bushing puller and installer indicates that it is an efficient tool. furthermore, its unique feature makes servicing safer and more convenient. Hence, the Bushing Puller and installer should adopt and must be available on the market to help the automotive industry, experts, instructors, trainees, and students.

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