

Development of Oil Seal Pressing Arrangement in Front Axle Assembly

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Abstract

Oil seals often called grease, fluid or dirt seals - close spaces between stationary and moving components in mechanical equipment, helping prevent lubricant escape. They also stop harmful contaminants from entering machinery, particularly in severe environments. Oil seal pressing instrument used in industries especially Company X is insufficient in performing their task. There is a problem of misalignment of the seal during fitment and also breakage of the seal due to extra force acting on it. Also some of the engines produced fail in the leak test and are rejected. They are disassembled and again the seal is pressed manually. This causes loss of time and power. In order to overcome the above problems a new method of oil seal pressing is developed using hydraulic cylinder and a tool of new design also developed. This new arrangement make use of the hydraulic cylinders and seal pressing tool that they help to provide cushioning action to the seal whereby which the seal itself fits into its place accordingly when pressed. During the test the leak of oil is reduced. It also reduces the force that is applied on the seal and prevents breakage. A revolutionary change has taken place in the field of fluid power technology due to hydraulic components and systems. Efforts have been made to include the latest possible trends in the field of hydraulics and allied control areas to keep the ever changing state of the technology in hydraulics. Our paper is to use the pascal's law by designing of hydraulic cylinder and implement in the oil seal pressing arrangement in bush pressing machine.

Keywords

Oilsealpressing, Frontaxleassembly

I. Introduction

In this project we have planned to design and modify the oil seal pressing arrangement in axle arm bush by using hydraulic power in the LA10353 axle arm bush pressing machine.

A. Objective of The Project

The objective of the project is to modify the oil seal pressing arrangement in axle arm bush to reduce the human effort and to use that manual power for some other application to enhance the productivity and efficiency of the production. Considering this we made detailed analysis and put a great effort to make this project.

B. Front Axle

An **axle** is a central shaft for a rotating wheel or gear. On wheeled vehicles, the axle may be fixed to the wheels, rotating with them, or fixed to the vehicle, with the wheels rotating around the axle. In the former case, bearings or bushings are provided at the mounting points where the axle is supported. In the latter case, a bearing or bushing sits inside a central hole in the wheel to allow the wheel or gear to rotate around the axle. Sometimes, especially on bicycles, the latter type axle is referred to as a spindle.

On cars and trucks, several senses of the word "axle" occur in casual usage, referring to the shaft itself, its housing, or simply any transverse pair of wheels. Strictly speaking, a shaft which rotates with the wheel, being either bolted or splined in fixed relation to it, is called an "axle" or "axle shaft". However, in looser usage an entire assembly including the surrounding "axle housing" (typically a casting) is also called an "axle".

An even broader (somewhat figurative) sense of the word refers to every pair of parallel wheels on opposite sides of the vehicle, regardless of their mechanical connection to each other and to the vehicle frame or body. Thus, transverse pairs of wheels in an

independent suspension may be called "an axle" in some contexts. This very loose definition of "axle" is often used in assessing toll roads or vehicle taxes, and is taken as a rough proxy for the overall weight-bearing capacity of a vehicle, and its potential for causing wear or damage to roadway surfaces. Axles are an integral component of most practical wheeled vehicles. In a live-axle suspension system, the axles serve to transmit driving torque to the wheel, as well as to maintain the position of the wheels relative to each other and to the vehicle body. The axles in this system must also bear the weight of the vehicle plus any cargo. A non-driving axle, such as the front beam axle in heavy duty trucks and some 2-wheel drive light trucks and vans, will have no shaft, and serves only as a suspension and steering component. Conversely, many front wheel drive cars have a solid rear beam axle.

C. Structural Features

A straight axle is a single rigid shaft connecting a wheel on the left side of the vehicle to a wheel on the right side. The axis of rotation fixed by the axle is common to both wheels. Such a design can keep the wheel positions steady under heavy stress, and can therefore support heavy loads. Straight axles are used on trains (that is locomotives and railway wagons), for the rear axles of commercial trucks, and on heavy duty off-road vehicles. The axle can optionally be protected and further reinforced by enclosing the length of the axle in a housing.

In split-axle designs, the wheel on each side is attached to a separate shaft. Modern passenger cars have split drive axles. In some designs, this allows independent suspension of the left and right wheels, and therefore a smoother ride. Even when the suspension is not independent, split axles permit the use of a differential, allowing the left and right drive wheels to be driven at different speeds as the automobile turns, improving traction and extending tire life.

A tandem axle is a group of two or more axles situated close together. Truck designs will use such a configuration to provide a greater weight capacity than a single axle. Semi trailers usually have a tandem axle at the rear.

Axles are typically made from SAE grade 41xx steel or SAE grade 10xx steel. SAE grade 41xx steel is commonly known as chrome-molybdenum steel (or "chrome-moly") while SAE grade 10xx steel is known as carbon steel. The primary differences between the two are that chrome-moly steel is significantly more resistant to bending or breaking, but is very difficult to weld with tools normally found outside a professional welding shop.

D. Axle Assembly Shop in The Plant Front Axle Assembly:

STAGE 1:

Axle beam is loaded on the conveyer belt.

STAGE 2:

Number is punched on the axle beam.

STAGE 3:

Axle arm is fitted on the beam for steering.

STAGE 4:

Steering rod is fitted. It is right end of the axle according to Indian STDs.

STAGE 5:

Tracking rod is fitted. It is used for alignment of the wheel. It helps the left side of the turn along with the right side wheel.

STAGE 6:

Brake carriers with brake linings are fitted to the FR axle beam and taken to chassis assembled.

REAR AXLE ASSEMBLY:

STAGE 1:

Banjo casting from outside is unloaded and fixed on the conveyer and axle shaft is removed.

STAGE 2:

Brake lining and 10 bolt and washer are fixed on the brake carrier with spring washer. Dust cover is also fitted.

STAGE 3:

Brake nut and bolt are tighten fitted 75 to 50 torques.

STAGE 4:

Ring for oil seal is fitted on the hub shim is fitted 3-6tau for the clearance flange cover is fitted with 4 bolts.

STAGE 5:

Inner oil seal is fitted on ring for inner oil seal. Inner wheel bearing is fitted.

STAGE 6:

Distance piece is fixed to align the inner and outer wheel bearing in the same axis.

STAGE 7:

Dry set, where the wheel hub is fixed roughly to verify where to increase the shim.

STAGE 8:

Where grease is packed inside the wheel hub.

STAGE 9:

Axle tube nut is fixed with counter pin and bolt, 190 tightness.

The give, studs are fixed

in the hub to shaft. Grease nipple is fixed on the wheel hub.

STAGE 10:

Drum is fixed 8mm blot is fitted.

STAGE 11:

Axle shaft is fitted using 8 spring washer and nut on the stud.

STAGE 12:

Complete assembly of rear axle is unloaded and taken to chassis assembly.

E. Sealing

The main function of a seal is to prevent the fluid (e.g. lubricant or air) to leak from shaft and housing. It can also prevent dust and mud to contaminate the housing. If dust and mud invade the housing, the life of transmission machinery will decrease greatly. The figure below is an illustration of a seal installed in one part of engine.

II. Literature Survey

Oil seals are commonly employed in many applications which require that a fluid (primarily lubricating oil) be prevented from migrating along a moving shaft. An important part of the development process of a sealing system is the rigorous testing of the new design. Normally comprehensive qualification testing of the sealing systems as well as 100% functional testing of production units prior to delivery is performed. Comprehensive research, analysis and testing of metals, polymers, thermoplastics and composites enables to develop and utilize materials that are best suited for the application. Factors such as strength, hardness, corrosion, temperature, fatigue, wear, friction, lubricity, elongation and extrusion are considered. Mindful of commercial issues, the material evaluation process also takes into consideration issues such as cost, availability and sourcing. Oil leakage is a very serious problem. If oil level decreases it increases friction resistance, and overall efficiency gets reduced. For a manufacturer, leakage testing of oil seal is necessary to evaluate its performance and sustainability in the working conditions specified by the user. Before manufacturing of bulk quantities is commenced, necessary design changes need to be incorporated if the performance is not satisfactory. The main objectives of the oil seal testing machine are to test the performance of oil seals in actual operating conditions by varying the test parameters and to verify if the oil seals can sustain the conditions of the test and last for the required duration without leakage. The machine developed in the project is capable of testing different types of seals with respect to the various parameters such as temperature, viscosity of lubricant and rotational speed.

1. Existing Methods

In this arrangement the tapered opening spring return oil seal fitter

is placed in the center of the fixture. The oil seal can be fitted on the both the sides of the this device. During the operation of the machine a ram which is provided under the fixture is moved up and made contact with the centrally placed oil seal fitter.

Due to this contact the force given to this device and which makes the device to get expand and there by pressing the oil seal into the bore of the axle arm.

At the same time two hydraulic cylinders provided on the both the left and right of the fixture is actuated to press the bush into the bore.



Fig 2.1 : Oil Filter

III. Methodology

A. Components

1. Hydraulic Cylinder

Hydraulic cylinders get their power from pressurized hydraulic fluid which is typically oil. The hydraulic cylinder consists of a cylinder barrel, in which a piston connected to a piston rod moves back and forth. The barrel is closed on one end by the cylinder bottom (also called the cap) and the other end by the cylinder head (also called the gland) where the piston rod comes out of the cylinder. The piston has sliding rings and seals. The piston divides the inside of the cylinder into two chambers, the bottom chamber (cap end) and the piston rod side chamber (rod end / head end). Flanges, trunnion, clevises, Lugs are common cylinder mounting options. The piston rod also has mounting attachments to connect the cylinder to the object or machine component that it is pushing / pulling.

A hydraulic cylinder is the actuator or “motor” side of this system. The “generator” side of the hydraulic system is the hydraulic pump which brings in a fixed or regulated flow of oil to the hydraulic cylinder, to move the piston. The piston pushes the oil in the other chamber back to the reservoir. If we assume that the oil enters from cap end, during extension stroke, and the oil pressure in the rod end / head end is approximately zero, the force F on the piston rod equals the pressure P in the cylinder times the piston area A :

2. OIL SEAL

Oil seals - often called grease, fluid or dirt seals - close spaces between stationary and moving components in mechanical equipment, helping prevent lubricant escape. They also stop harmful contaminants from entering machinery, particularly in severe environments. Vital components of practically every type of machine and vehicle in operation, oil seals protect all types of precision-constructed, close-fitting ball, sleeve and roller bearings.

A device for preventing the entry or return of oil from a chamber. A device using oil as the sealing medium to prevent the passage of fluid from one chamber another. They protect all types of bearings and serve three basic functions:

Retaining lubricants and liquids. Excluding contaminants. Seal or separate dissimilar fluids or gases.



Fig 3.1. Oil Seal Filter

B. Working Principle

1. Axle Arm Bush Pressing Machine

Axle arm bush pressing machine is a machine which is used to press the bush and oil seal into the bore of the front axle arm. The fitting of oil seal and bush is to avoid the leakage of oil, leading to avoid the frequent failure due to leakage. The fitting of bush is also used to perfectly fit the king pin between the two jaws of the front axle arm.

The machine has a horizontal work table and carries a sliding type conveyor provision to move the component (i.e) axle arm after the completion of fitting the both the bush and the oil seal.

The machine has two fixtures. In one fixture an operator can perform the fitting of both the oil seal and bush at a same time. This is done by providing two hydraulic cylinders at the both sides of the fixture and providing the ram which can move up and down at the center of the fixture. At the center of the fixture an arrangement is there to fix the oil seal fitter which is a spring return type. At both the sides of the sides of the oil seal fitter an oil seal can be placed. This device has a tapered opening, when the ram is moved up it will expand the oil seal fitter device there by it will fit the oil seal in the axle arm. At the same time the bush can be inserted into the bore of axle arm by using reciprocating of piston of the hydraulic cylinder.

In this method the tapered opening gets wear and the device gets damaged. Due to this the oil seal fitter is not expanding in a equal manner and the oil seal is not seated perfectly. This will lead to the wastage of oil seal and during quality inspection the component may be rejected. So the oil seal has to be fitted again by manually by hammering action.



Fig 3.2. Axle bush pressing machine

C. Operating Controls And Procedure

Push button - to start the machine
 Push button - for loading the bushes in the bush load box. The bush load box should be kept at -5 degree Celsius.
 Push button- for supplying the hydraulic fluid into the cylinder.
 Fix the oil seal in the two sides of the oil seal fitter. Push button – to bring the bush to the face of the cylinder piston
 Push button- to press the bush into the bore of the axle arm
 Push button – to bring the ram up and expand the oil seal fitter.
 Push button – to fix the stroke length of the hydraulic cylinder piston
 Push button – for forward stroke Push button- for reverse stroke
 Unload the axle arm after fitting of both the oil seal and the bush.
 Emergency stop push button for emergency stop. Push button- for turn off the machine.

CAD MODELLING

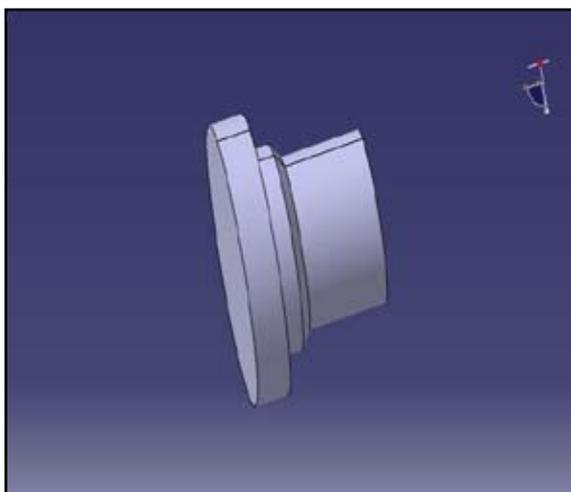


Fig 3.3. CAD Modeling of oil filter

An **oil seal filter** is a filter designed to remove contaminants from engine oil, transmission oil, lubricating oil, or hydraulic oil. Oil filters are used in many different types of hydraulic machinery. A chief use of the oil filter is in internal- combustion engines in on- and off- road motor vehicles, light aircraft, various naval vessels. Other vehicle hydraulic systems, such as those in automatic transmissions and power steering, are often equipped with an oil filter. Gas turbine engines, such as those on jet aircraft,

also require the use of oil filters. Aside from these uses, oil production, transport, and recycling facilities also employ filters in the manufacturing process.

Mechanical

Mechanical designs employ an element made of bulk material (such as cotton waste) or pleated filter paper to entrap and sequester suspended contaminants. As material builds up on the filtration medium, oil flow is progressively restricted. This requires periodic replacement of the filter element (or the entire filter, if the element is not separately replaceable).

D. Design of New Method

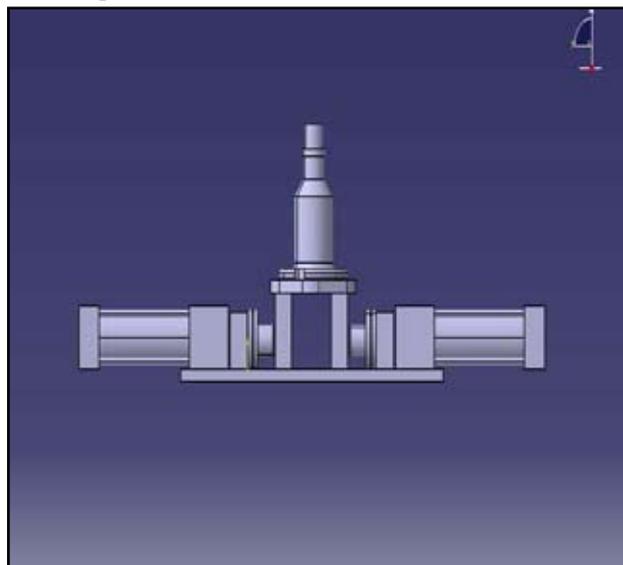


Fig 3.4 : Front view of the model

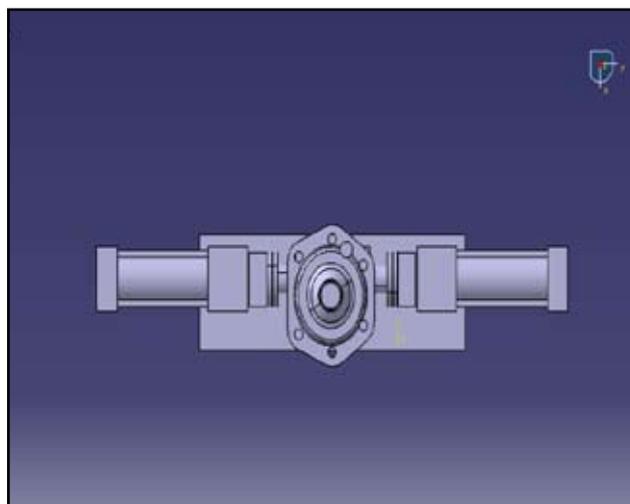


Fig 3.5 : Top view of the model

IV. Analysis of Problem

In the above two cycle of operations, the pressing of oil seal into the axle arm bore to avoid leakage is being a issue in the Company X. In the first method wear out of tapered part and in second method the manual hammering of oil seal producing the limitations in every manner.

These limitations includes imperfect seating of oil seal, wastage of oil seal, loss of man power, decrease in quality, loss in production time, loss in production, quality defects, etc.,

A. Possible Solutions

The possible solutions to overcome the above problems is to make the process to automatic without the usage of the spring return tapered oil seal fitter and manual hammering. For this various options are analysed and the following three options were short listed.

Mechanical system Hydraulic system Pneumatic system

B. Mechanical System

Mechanical actuation is possible using gears, levers, cranks and pulleys which might then increase the cost of automatization since mechanical components are costlier compared to other devices. Using mechanical actuator would gradually increase the weight which might not be suitable to place on the machine.

C. Pneumatic System

Pneumatic actuators are light in weight and are less expensive compared to hydraulic system. There is no need for separate power pack as like in hydraulic system since it is fully depends on the compressed air.

Though it seems to be advantageous it is not suited for this application. Since air is compressible it can be compressed up to the maximum extent. So the pressure produced by this system will be many times greater than the hydraulic system. Also, slow motion of piston is needed, which is difficult to attain in pneumatic system.

D. Hydraulic System

Though the cost of hydraulic actuators are quite high and need of separate hydraulic power pack it is been considered as a perfect suit for this application. This is why because means we can obtain the slow motion which is exactly needed to press the oil seal into the bore of the axle arm. Also the pressure requirement can be obtainable. The advantage over pneumatic system is hydraulic fluid cannot be compressed so it can be very much used for high load applications. This is cannot be made with the pneumatic system.

E. Best Solution

Though the hydraulic system has a fewer advantages than the pneumatic, it is considered to be the best solution because of the achievement of slow motion needed to press the oil seal and the pressure needed and also the withstand of high load applications.

Hence the hydraulic system is considered to be the best solution for this process.

F. Hydraulic Cylinder

A hydraulic cylinder is a mechanical actuator that is used to give a unidirectional force through a unidirectional stroke. It has many applications, notably in construction equipment (engineering vehicles), manufacturing machinery, and civil engineering.

Flanges, trunnions, clevises, Lugs are common cylinder mounting options. The piston rod also has mounting attachments to connect the cylinder to the object or machine component that it is pushing / pulling.

A hydraulic cylinder is the actuator or "motor" side of this system. The "generator" side of the hydraulic system is the hydraulic pump which brings in a fixed or regulated flow of oil to the hydraulic cylinder, to move the piston. The piston pushes the oil in the other chamber back to the reservoir. If we assume that the oil enters from

cap end, during extension stroke, and the oil pressure in the rod end / head end is approximately zero, the force F on the piston rod equals the pressure P in the cylinder times the piston area A :

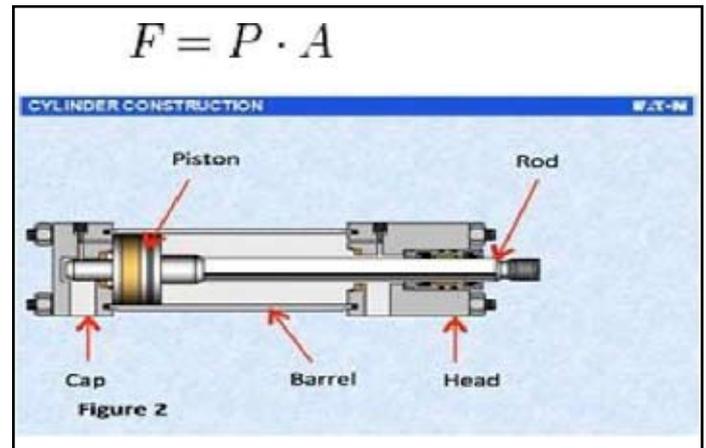


Fig. 4.1 : Working of the hydraulic cylinder

Retraction force difference

For double-acting single-rod cylinders, when the input and output pressures are reversed, there is a force difference between the two sides of the piston due to one side of the piston being covered by the rod attached to it. The cylinder rod reduces the surface area of the piston and reduces the force that can be applied for the retraction stroke. [2]

During the retraction stroke, if oil is pumped into the head (or gland) at the rod end and the oil from the cap end flows back to the reservoir without pressure, the fluid pressure in the rod end is (Pull Force) / (piston area - piston rod area):

$$P = \frac{F_p}{A_p - A_r}$$

where P is the fluid pressure, F_p is the pulling force, A_p is the piston face area and A_r is the rod cross-section area.

For double-acting, double-rod cylinders, when the piston surface area is equally covered by a rod of equal size on both sides of the head, there is no force difference. Such cylinders typically have their cylinder body affixed to a stationary mount. The forces on the piston face and the Piston Head Retainer vary depending on what Piston Head retention system is used.

If a circlip (or any non preloaded system) is used, the force acting to separate the Piston Head and the Cylinder Shaft shoulder is the applied pressure multiplied by the area of the Piston Head. The Piston Head and Shaft shoulder will separate and the load is fully reacted by the Piston Head Retainer.

If a preloaded system is used the force between the Cylinder Shaft and Piston Head is initially the Piston Head Retainer preload value. Once pressure is applied this force will reduce. The Piston Head and Cylinder Shaft shoulder will remain in contact unless the applied pressure multiplied by Piston Head area exceeds the preload.

The maximum force the Piston Head Retainer will see is the larger of the preload and the applied pressure multiplied by the full Piston Head area. It is interesting to note that the load on the Piston Head Retainer is greater than the external load, which is due to the reduced shaft size passing through the Piston Head. Increasing this portion of shaft reduces the load on the Retainer



Fig 4.2 : Hydraulic cylinder

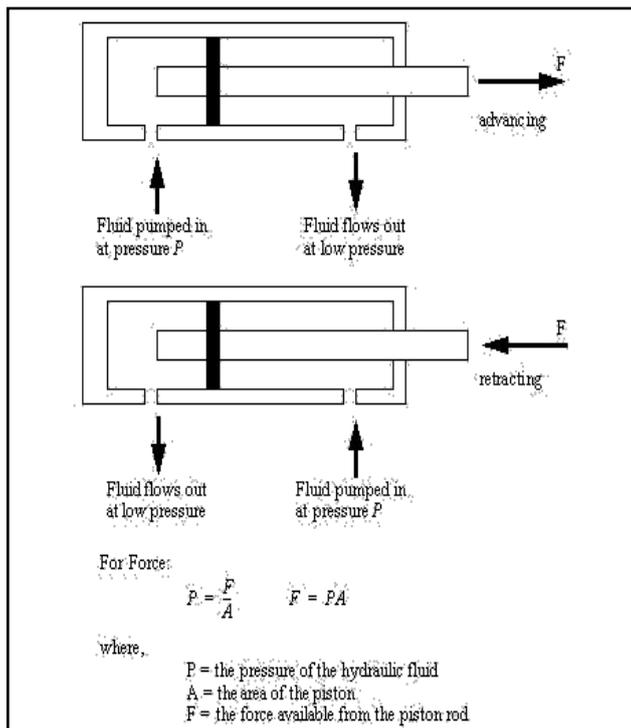


Fig. 4.3: Detraction and Retraction of cylinder

V. Results And Implementation

1. Implementation of New Method

The hydraulic circuit with the hydraulic cylinder is kept on a both the sides of the fixture. To load and unload the front axle arm sliding type conveyor is used with the work table. The dimensions of hydraulic cylinder are calculated to fit for the application and thus calculated diameter is used in this method. The pressure required to press the oil seal to the axle arm bore is calculated and the calculated pressure was set by use of hydraulic power pack and the pressure is supplied by hydraulic fluid stored in the power pack.

Next a device that is used to fit the oil seal perfectly in the bore of front axle is designed. The design of this device is in such a manner that it can perfectly seat the oil seal. The stroke of the piston should be set till the combination of piston and oil seal fitter perfectly seat the oil seal. Before applied into the usage please ensure that proper cushioning action is occurring. In this method pressing of oil seal and pressing of bush is carried out in two separate process. First the oil seal is fitted then the axle arm is brought to the next fixture on the same work table.

Here the bush is pressed by the method that is used earlier.

2. Working of The New Proposed Method

First the axle arm is brought to the worktable fixture.

Then the oil seal is fixed in the oil seal fitter that connected to the piston of the hydraulic cylinder. It is done on the both the sides of the fixture because two oil seal is fitted.

Then the pressure is supplied to the hydraulic fluid by pressing the push button on the control panel of the machine. After the button is pressed, the oil seal fitted to the axle arm bore to avoid oil leakage.

Next the axle arm is brought to the next fixture on the same work table provided just before to the oil seal arrangement. Then by pressing the push button from control panel the already loaded bush is brought up to the work point.

Then the hydraulic cylinder will perform the action to place or insert the bush into the axle arm bore on the both the upper and lower jaws of axle arm. Then the component after completion of inserting both the oil seal and the bush is given to other machine for performing further operations leading to production.

3. Merits of The New Method

Better leak proof quality when the axle arm passes to the quality test

Proper and perfect alignment of oil seal compared to the earlier methods.

Cushioning of seal helps it to align itself correctly Economical & Time saving.

Increase in productivity.

Loss of production time can be reduced Less human effort.

Increase in turn over of the company.

Due to the viscosity of fluid in hydraulic cylinder slows down the piston movement.

Process lean time reduces. Increase in production efficiency

VI. Conclusion

It is concluded that the “Modification of oil seal pressing arrangement in axle arm and seal pressing machine in the axle shop to avoid quality defects” has been completed successfully as per our objective oriented in the beginning.

Thus by using hydraulic system and a newly designed oil seal fitter device with the axle arm bush pressing machine, the perfection in cushioning and seating of oil seal into the bore of the axle arm is obtained. There by we achieved the no leakage as well as the increased quality in the component

Hence due to this new arrangement on LA10353 Axle arm bush pressing machine, quality defects is reduced and productivity is increased

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