Designing of an assembly machine for center deviation adaptive bearing pressure

[1] Arash Hosseinian Ahangarnejad, [2]Sina Abroumand Azar

[1]Department of Mechanical Engineering, Hacettepe University, Ankara, Turkey
[2]Department of Mechanical Engineering, Islamic Azad University, Tabriz, Iran

Abstract: Auto gear box is considered as the most important parts of a vehicle. The tapered roller bearing outer ring should be fitted to the shell before its assembly. The efficiency and performance of gearbox (transmission) is directly affected by the assembly precision. Through the research, design, test and manufacturing, eventually it was developed and used in automobile gearbox bearing pressure assembly machine. Therefore the automatic production is achieved, which improves the production efficiency, ensures the assembly quality, and brings higher profit to the enterprise.

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1. Introduction

One of the significant parts of automobile is the auto gear box. The tapered roller bearing outer ring that supports the transmission shaft should be fitted to the shell before its assembly. The performance of the gearbox is directly affected by the precision of assembly. At present, a gearbox company hasn't the specific assembly equipment, so the press mounting proceeds with simple hand tools. The first step is that the bearing outer ring is to be artificially installed after the shell is sent to the assembly workshop. Because human being press mounting can't parallel the advanced gearbox assembly line, this process has not been able to realize automation on the assembly line. Moreover, the beating in the manual press mounting caused high damage in the outer ring, and the unstable press mounting forcing resulted in the lower assembly precision, unstable quality and higher claim rate. The labour some beating movement in the manual press mounting increased the labour intensity that easily made the workers injured. Concurrently, the thunderous chiming had a great influence on the mental and physical health of workers, and the vicinity environment. If we assembled in the manner of the purely manual operation, the physical strength and mood of the workers will make a great effect on the quality of the press mounting and the production efficiency. In order to conform the requirements of the company development, we must improve the labor productivity, decrease the production cost and increase the assembly quality, therefore, we developed the press mounting machine for bearing.

2. The Main Technical Performance Indicators

2.1. Technical parameters of the Gearbox shell

The press mounting of the two bearing outer rings of the eight file gearbox shell (ND series) bearing hole of intermediate shaft (100K7 mm, the depth from hole plane to shell plane: 309 mm); bearing hole of the second shaft (110K7 mm, the depth from hole plane to shell plane: 293 mm); The center distance of two holes 148mm; supporting bearings both are cone bearings, cone bearing outer ring transition fit with bearing hole.

The press mounting of the two bearing outer rings of the nine file gearbox shell (T-series): bearing hole of intermediate shaft (100K7 mm, the depth from hole plane to shell plane: 437.4 mm); bearing hole of the second shaft (136.525K7 mm, the depth from hole plane to shell plane: 398.4 mm); The center distance of two holes 154mm; supporting bearings both are cone bearings, cone bearing outer ring transition fit with bearing hole.

2.2. Performance requirements

The machine can press-mount the bearing outer rings of intermediate shaft and the second shaft of the eight and nine file gearbox shell(ND.T series). The welding structures of frame parts ensure that equipment in use has enough rigidity. The working parts of the equipment work in the vertical manner. The maximum effective working height (the height of the fitting surface between the bearings with the shell) is 33 mm the minimum height is 20 mm. The operation space of the press-mounting machine should be given in the relevant data of the equipment, and the height of 50 mm must be reserved for shell heightening in new varieties. In order to meet the operational requirements, the working process of the press mounting should be stable and reliable. Besides, it should have enough protection measures for working environment to ensure that there is not environmental pollution in use. The bearing outer ring should be set in the head of spindle before the machine starting working. The center positioning error correction mechanism should be added to the

press head to ensure that it will not appear the partial pressed phenomenon in the mounting process.

The shell could be accurately located on the workbench by the dowel hole in its lower surface. There are lifting appliances in the workshop when feeding the shell. The lifting appliances with the corresponding charging and baiting agencies ensure that the operation is safe and that there will not be interference with the press equipment. The lifting appliance must have the characteristic of taking up little space and handiness.

The basic action of the vertical press mounting machine is: the positioning of gearbox shell, fast forward of Spindle, spindle working into, press mounting to the specified position (signal prompt), the rapid return of spindle, etc.

The press mounting machine may not cause any damage to the gearbox shell: while the shell was accurately located, its working part should have some auxiliary support. The press will be fixed on the ground of the second floor, so the bearing of per unite area unable be more than 700 kg. Beat requirements: The adjustment time in the switch of eight and nine file shall not exceed 10 minutes, and that in the press of the same lot Gearbox bearing should be less than 3 minutes.

The press should also meet the following technical parameters, besides the above technical index.

- The overall dimension 1860 1865 3152 mm;
- The maximum press mounting force: 100KN;
- Range 500 mm.

3. Overall Scheme and Working Principle

3.1. Overall scheme design

The press mounting machine is composed of Dragon Gate frame, press mounting

cylinder, the movable crossbeam, the center distance adjusting device, pressure head, guide pin, self-powered platform, lifting cylinder, guide rail, feeding dolly, the press controlled and tested system, which are shown in Figure 1: 1. The press mounting cylinder. 2. Dragon Gate frame. 3. The movable crossbeam. 4. The center distance adjusting device. 5. The Error correction mechanism. 6. The press head. 7. The bearing outer ring. 8. The guide pillar. 9. The gearbox shell. 10. The control cabinet. 11. The feeding tray. 12. The feeding dolly. 13. The guide rail. 14. The self-powered platform. 15. The lifting cylinder.

The Dragon Gate frame equipped with guide pin 13 and feeding dolly 14 is the body part of the equipment, through whose feeding automatic line the work-piece is delivered to the Feeding tray 12 of the press mounting device; under the instructions of control system, lift cylinder 15 carrying self-powered platform 14 moves download and locates feeding dolly on the frame workbench; After the feeding dolly was located, the device starts press operations. Under the instructions of control system, the press cylinder 1 drives the press head fixed on movable crossbeam 3 download movement, before this the bearing outer ring 7 has already been installed on the press head. When the press head drops to the designated location, the bearing outer ring starts to be mounted under the press mounting force provided by the supercharging device. Then the upward movement of the press cylinder and feeding cylinder makes the press head and the lift cylinder back to the initial position, so the work-piece returns to automatic production line and goes into the next procedure. There are there processes:

The installation process is auto-completed by automatic control system, so it only takes 50 seconds. The error correction mechanism fixed on the press head can adjust installation error in the real time. In order to adapt to the mounting requirements of many varieties, we install a center distance adjusting device 4 on the press head. The mounting machine adopts the pneumatic driving devices, so it can achieve the goal of environmental protection.

3.2. The Functional Scheme of Press Mounting Machine

The figure 2 express the functional scheme of press mounting machine, the following are the technological process and working principle.

1-The control valve of travel conversion.
2-The throttling control valve.
3-The elevating platform.
4-The lifting cylinder.
5-The workbench cylinder.
6-The workbench.
7-The gearbox.
8-The electrical control system.
9-The main control valve.
10-The airdraulic pressurization actuator.

At first, yoke bearing outer ring of the intermediate shaft and the second shaft to the head of pressure head assembly, and then hoist the gearbox shell center justified on the workbench 7. After pressing the automatic switch button, the workbench 7 equipped with gearbox shell moves along the guide rail 8 to the elevating platform 9, then the elevating platform carrying the workbench moves down, when the workbench is located on the base table-board of the mounting machine by locating pin, the airdraulic pressurization actuator carrying the movable crossbeam 3 connected to press head assembly moves down along the guide pillar.

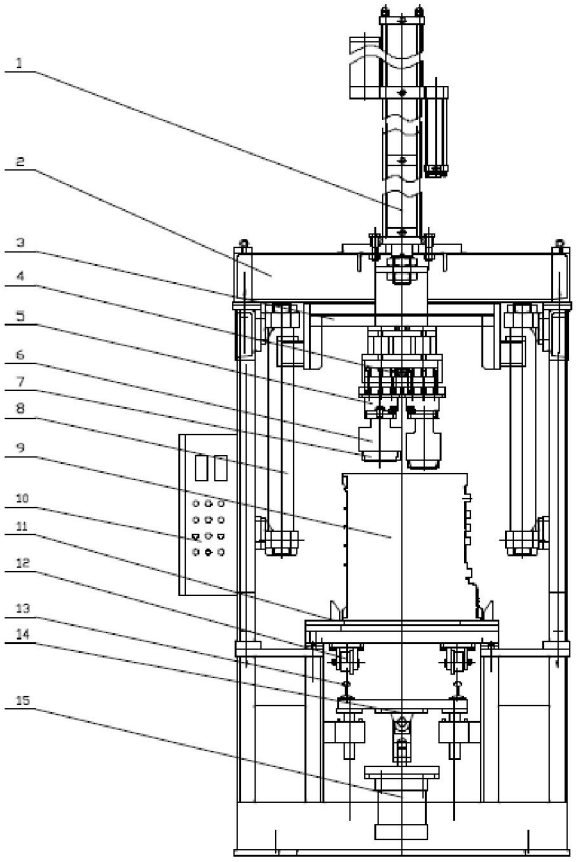


Figure 1. Structure diagram of the press mounting machine

Going through the fast moving stroke, press mounting process and rapid return stroke, the bearing outer ring is completely press mounted.

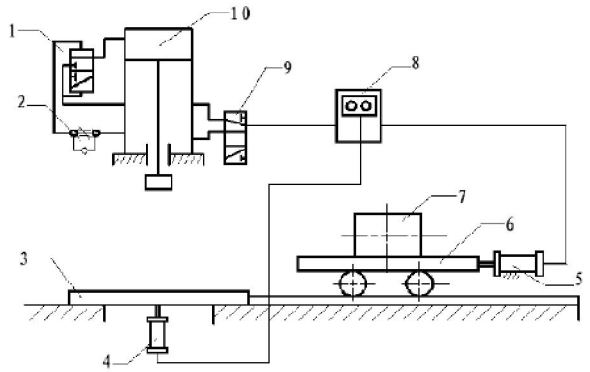
The upward movement of elevating platform removes the work table out of the base table-board of the mounting machine, then the workbench 7 equipped with gearbox shell moves along the guide rail 8 to the original position.

When the gearbox shell press mounted with the bearing outer ring is hoisted out of workbench, the press mounting of intermediate shaft bearing and the second shaft bearing is completed, the press mounting process enter the next cycle.

The modular press head and orientation block can be replaced rapidly, so the device can assemble different types of gearbox.

3.3. Pressure Assembly Process Action Process

Artificial will be installed in the pressure head bearing outer ring; The shell lift artificial crane placed in tray feed unit on pressure into the installed working mesa; Tray feed unit and shell positioning clamping; Gas to liquid pressurization cylinder fast forward; Gas to liquid pressurization cylinder into work; Being connected in place (signal display); Gas to liquid pressurization cylinder in situ quick return. The process of control chart action process, see figure 3.



3.4. The Introduction of the Assembly Pressure Device

Being connected device is the key part of the pressure installed, because it to adapt to the eight block, nine of the existing when pressed against the requirements of the pressure difference, so will the design into a modular, can change quickly, its core part is the pressure head, here will pressure head design into three claws "hook pressure head, as shown in Figure 4. Three claws hook pressure head it is simulation hand structure design the independent research and development.

1- by three claws hook;
2- Electromagnet push rod;
3- Bearing inner circle cylinder (cone) modeling

It has not put bearing outer ring, third claw in spring pressure under the action of Justice in the state. When will the trap into bearing, three claws and hold bearing outer ring hook end under, and bearing inner circle cylinder (cone) modeling cooperation; When bearing outer ring pressed 8 ~ 10 mm, three claws in electromagnet push rod under the function of the contraction from end, make bearing pressure in place; Cylinder to return to in situ, electromagnet push rod reset, and three claws open, into the next cycle.

In order to eliminate installation yes error, in the pressure head installed the Center position error correction mechanism Center-Master, automatic revision pressure fashionable pressure head and the error between the various spare parts.

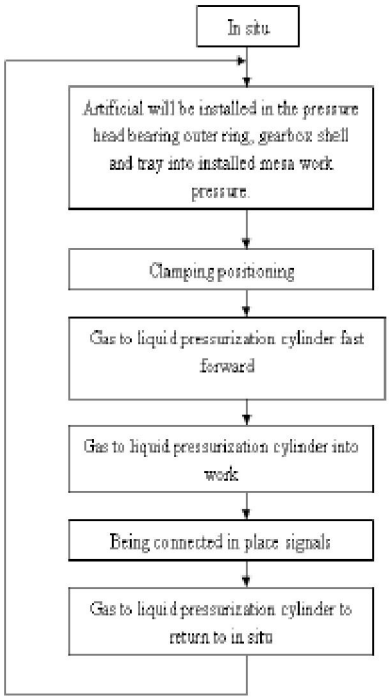


Figure 3. Pressure assembly process action process

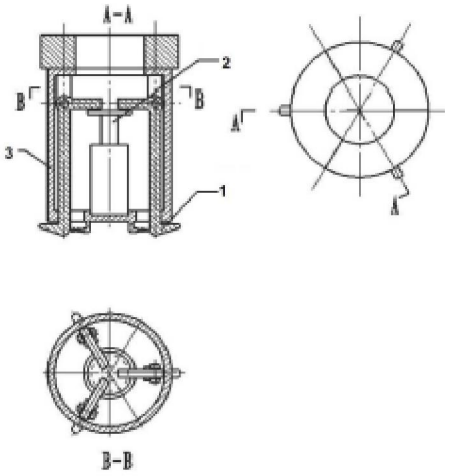


Figure 4. Three claws hook pressure head

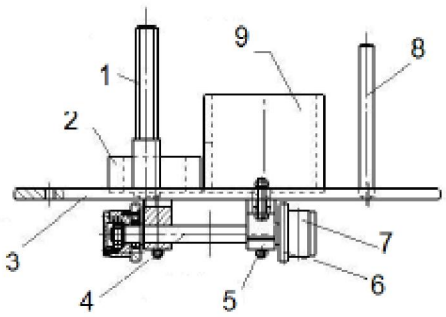


Figure 5. Tray feed unit

3.5. Tray Feed Unit

Tray feed unit by tray and roller system and other components, as shown in Figure 5.

1-Diamond pins
2-Small gasket
3-Junction plate
4-Roll wheel
5-Support a
6-Retainer ring
7-Idler wheel
8-Cylindrical pins
9-Big gasket

Tray design positioning holes, pins and auxiliary support device, can will pressure the pressure inside the installed consumption, ensure the ground not bearing, wheel system have the function of the transmission. In the switch when the product, with the other a corresponding tray feed unit.

4. The Key Technologies

To meet the requirements of the production actual situation and product technology, the development project needs to study and solve the key technologies and features as follows:

- The press mounting technology of matching multiple holes located in the depths of the gearbox with tapered roller bearing outer ring.
- We need design a novel parallel long pole press head, which should automatically modify the error between the center axis of press head and that of bearing hole while matching multiple holes located in the depths of the gearbox with tapered roller bearing outer ring.
- It should achieve the grab and clamping of tapered roller bearing outer ring and flexibly assemble different kinds of gearbox.

5. Innovative Points

We solved the problem of matching multiple holes located in the depths of the gearbox with

tapered roller bearing outer ring by parallel long pole multiple press heads. Besides, we developed independently a center deviation correction device which can automatically modify the error between the center axis of press head and that of bearing hole in the process of press mounting.

We developed independently a novel telescopic pressure head which can be used in the press mounting of multiple holes located in the depths of the gearbox and tapered roller bearing outer ring. It can grab and clamp bearing by the support board, spring and ball installed on the head. In addition, the press mounting can also be completed in the parts of blind hole, ladder hole and through-hole, etc. The modular pressure head and orientation block can be replaced rapidly, so the device can assemble many different bearings of varieties gearbox.

6. Conclusions

We developed independently a novel press-mounting machine, which solved the

Problem of matching multiple holes located in the depths of the gearbox with tapered roller bearing outer ring by parallel long pole multiple press heads. It can modify automatically the deviation between the center axis of press head and that of bearing hole in the process of press mounting. We developed independently a novel telescopic pressure head which can be used in the press mounting of multiple holes located in the depths of the gearbox and tapered roller bearing outer ring. It can grab and clamp bearing by the support board, spring and ball installed on the head. In additions, the press-mounting can also be completed in the parts of blind hole, ladder hole and through-hole, etc. Under the control of automatic control system, the machine can press-mount automatically a variety of gearbox bearings. The pressure installed in a transmission Co., LTD has been put into operation, after workers and technicians of the operation, think that the high degree of automation equipment and machines, electric control less component, workers in a short period of time will be familiar with the operation, do not need to separate technical training. Think this equipment reasonable design, simple operation, convenient maintenance, reliable operation, and the technical properties can meet the design requirements.

The application of this technology, effectively improve the productivity, reduce the labor intensity of the workers, improve the working environment and by the user high praise, has achieved good economic benefit and social benefit. The technology can be applied to other bearing collar or disk parts assembly. The technology to promote national automobile industry science and technology progress and development has great role, and we are going to the application, and strive for the development of the car industry to make our due contribution.

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