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IMPROVING THE RELIABILITY OF AN AUTOMATED PNEUMATIC BEARING PRESS EQUIPMENT USED IN THE AUTOMOTIVE INDUSTRY

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Abstract: *The process of pressing the bearings in the pressing stations, although a simple process at a first approach, requires pneumatic, hydraulic, mechanical and electrically operated equipment, with a corresponding reliability, which meets the quality requirements. The paper deals with a technical solution regarding the pressing of axial bearings in the gearboxes of motor vehicles. Since the initial process caused both the destruction of the bearings and subsequent problems with the operation of the gearbox, the concept of the pressing station was modified and improved.*

Keywords: *Bearing, press equipment, pneumatic, automotive industry*

1. Introduction

A technological assembly process means a sequence of operations and actions in certain time intervals and in a well-established order, resulting in an assembly or product that is functional at certain parameters and that meets certain requirements at the highest possible level. [1], [2]
In the assembly process we can find three types of automation levels and they are:

- Manual - when only the action of an operator/worker is needed in the assembly process
- Mechanized - when the operator, with the help of a mechanical system (for example: mechanical press), carries out an assembly process
- Automated - by automated process is understood the equipping of some installations with devices that ensure the completion of assembly operations, without the intervention of an operator. In most cases, in the assembly process there are workstations that belong to all three categories.

Press assembly of bearings is an operation by which a shaft-type part and a bore-type part are brought to the physical state in which tightening forces appear between them, to lead to the locking of the assembly. [3 - 5]
Bearings are used to support parts that perform rotational or oscillating movements. In their assembly, the following stages must be considered:

- The bearings and the other elements that make up the assembly will be chosen according to the gauge and the force applied to the respective assembly
- The symbolization, the radial beat and/or the frontal beat will be checked
- Checking the cracks and the slots where the bearings are inserted
- It will be considered that the elements to be assembled are positioned correctly
- The actual mounting of the bearings
- Checking the adjustment and the clearance
- Inserting the shaft into the body of the bearings
- Fitting the covers

Each mounting method presents a different degree of complexity, which brings with it a series of advantages and disadvantages. [4], [5]
Manual assembly It is done by an operator or worker and consists in the fact that he performs the assembly operation by hand, without the need for auxiliary tools.
Usually, the pieces that will be mounted in this way have clips in their construction to be able to press easily or the assembly between the borehole and the shaft does not require high pressing forces.

We find advantages like • Low costs, but also disadvantages like: • Low reliability; • Low process repeatability; • Possible assembly errors.
Mechanized assembly aims to replace manual work with technical means (machines, devices, stations, tools and mechanisms, etc.) to be able to perform some operations, with the worker only having to adjust and control the operation of the machines.
In the assembly activity, simple mechanization is achieved by using tools, instruments, devices and stations, which make work easier or even replace it.
It has the advantage that it ensures high productivity, and a better quality of the work performed.
Complex mechanization consists in the introduction of assembly lines, on which actual assembly work is performed, but also preparatory, auxiliary or final work.
Automated pneumatic assembly, the highest level of mechanization, and within it, control functions are also performed, with the operator only having the attribution of adjustment and supervision.
This automation technique has applicability in all technological fields.
To measure certain values, a series of special automation procedures have been developed that have led to the production of a wide variety of sensors (flow, pressure, temperature).
As a control, instead of fixed links between the execution elements and sensors, a PLC (programmable logic controller) is used, which is a flexible system.
The higher the degree of automation, the higher the need for sensors and actuators (execution elements). Different types of local networks have been created for communication between them.
In order to have high-speed connections, some installations have implemented closed local systems that work to process the signal in real time without delays.
It is necessary for the operator to be informed sufficiently and in a timely manner, without errors, to be able to make the right decisions.
The control panel must be easily accessible and intuitive for easy understanding.
As safety methods, compliance with all regulations is an important condition for creating safe machines and systems.

2. Improving the reliability of the automated bearing press equipment

Improving the reliability of the pneumatic bearing pressing station required changing the initial working concept, the modified press station is shown in figure 1.

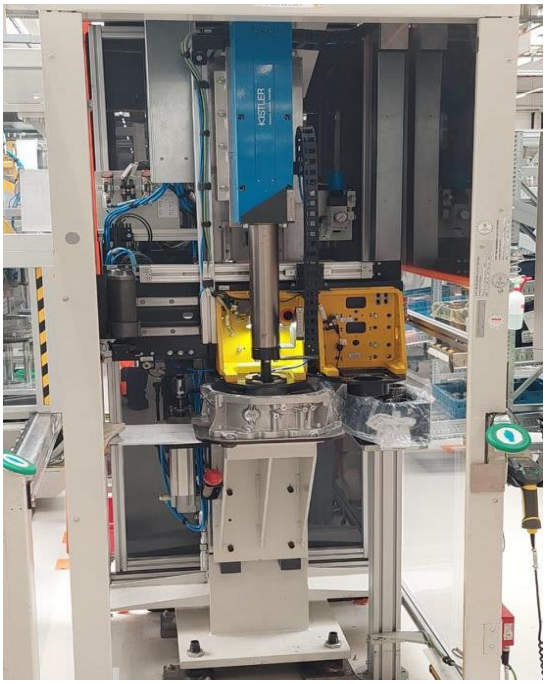

Fig. 1. Modified press station

The process was very extensive and required the redesign of the pneumatic actuation schemes, specific sizing calculations for the equipment used, the inclusion of sensors and command and control systems.
The actuation schemes of the pressing cylinders for the bearings that will be mounted in the housing in figure 2, is presented in figures 3 (door cylinder) and 4 (main cylinder), respectively.

Fig. 2. Bearing housing

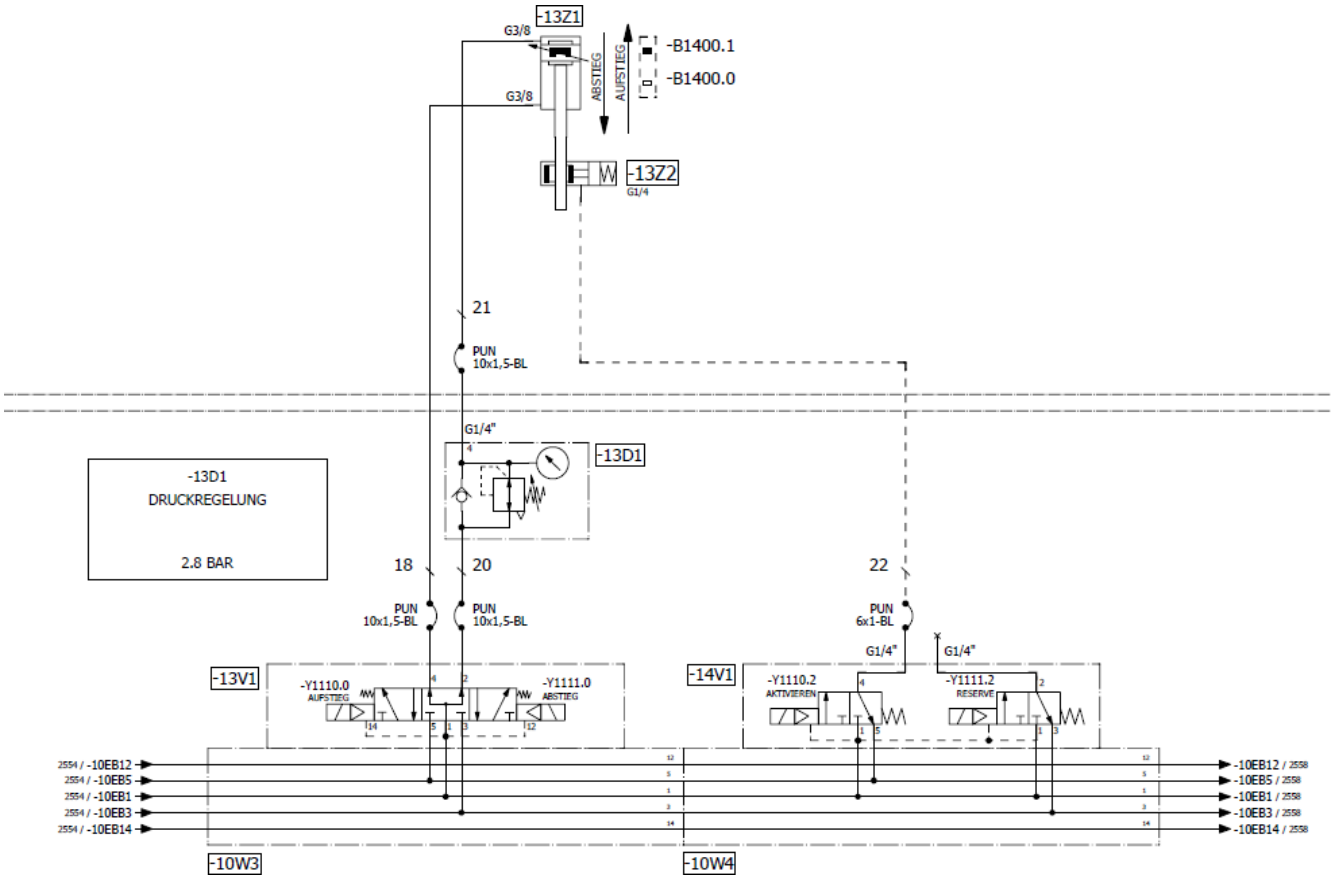

Fig. 3. Pneumatic diagram for cylinder 1A

On the first stage, the air flow needed in the pressing process was theoretically evaluated for each individual cylinder, considering the change in pressures and temperatures during operation, like figure 5 shows for the cylinder 1A.

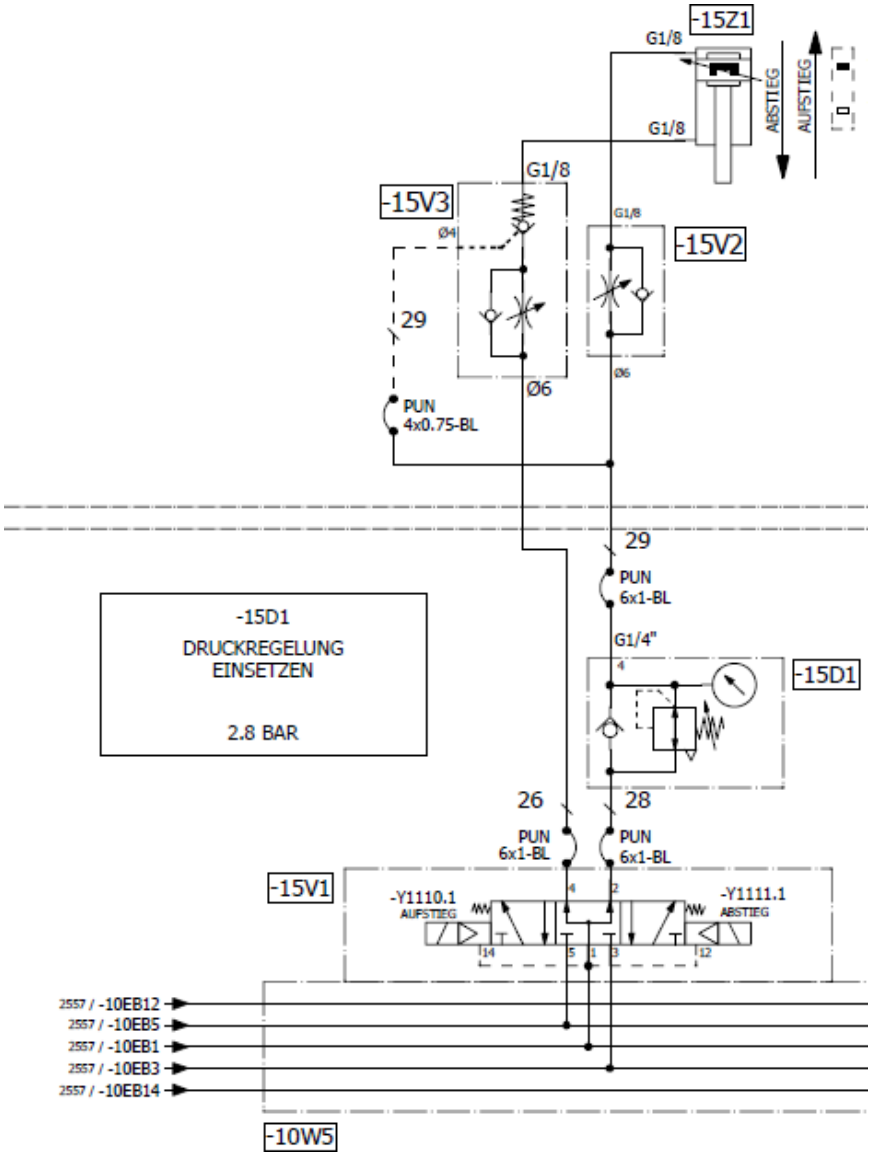

Fig. 4. Pneumatic diagram for cylinder 2A

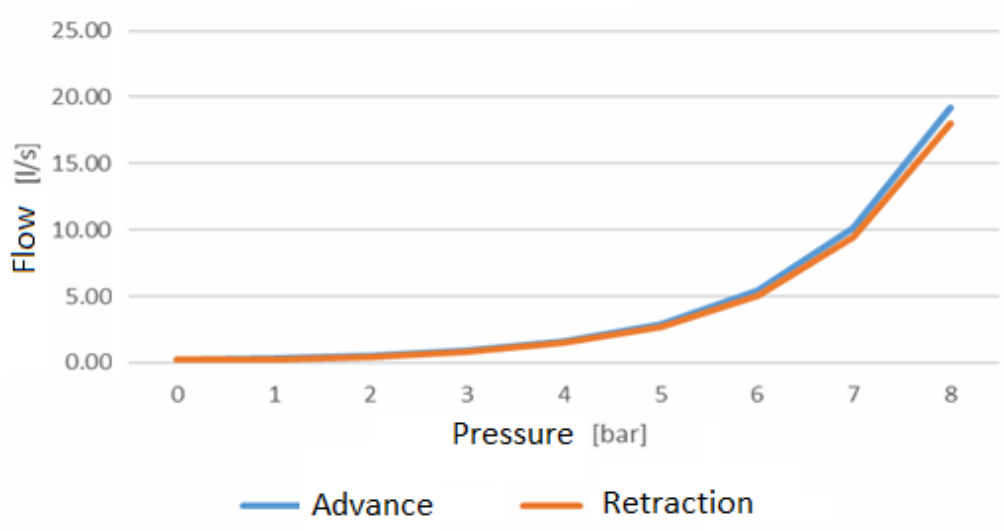

Fig. 5. Required air flow in cylinder 1A

In the pneumatic actuation version, the cylinder that performs the pressing operation of the two axial bearings is controlled on the advance and retreat stroke by a directional control valve, the force on the advance stroke being set by a pressure regulator valve. The studies carried out on the equipment led to the conclusion that it is very difficult to control the exact pressing process, the mounted bearings being with a high probability in incorrect positions.
Since the modernization of the pneumatic system would have generated quite high costs, without having a clear perspective on the quality of the pressing process, the use of an electric, automated system was considered.
Figure 6 basically shows the electric servo motor used for tests on the pressing station. [6]

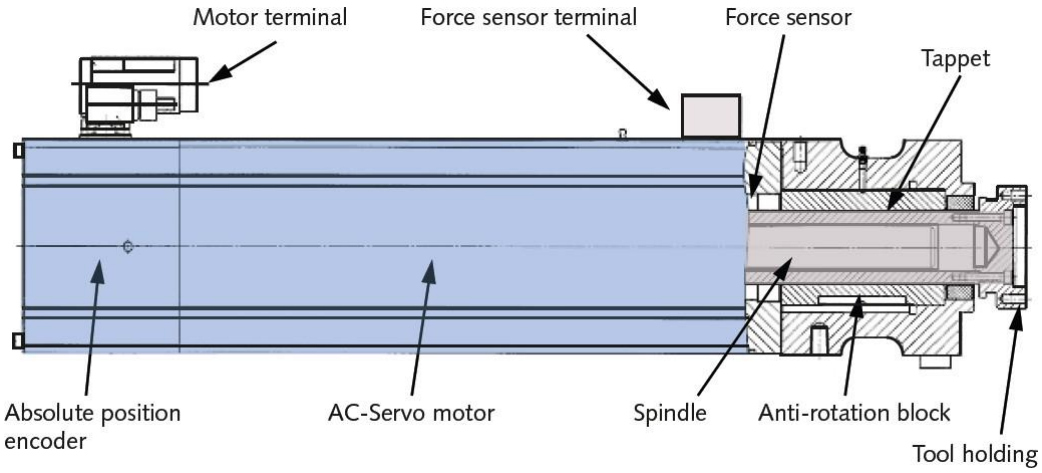

Fig. 6. The electric servo motor

Such a servomotor, of special construction, has high dynamics and drives a ball screw, so that the rotation is transformed into a forward movement through an integrated ball groove. The drive is based on the tubular shaft motor principle. The extremely compact design is achieved so that the screw drive passes through both the force sensor and the drive motor.
The integrated force sensor can absorb compression and tension forces, so that jointing processes with subsequent tensile testing are possible, and the monitoring and evaluation system is a maXYmos NC type 5847A. The pressing process is controlled by machine PLC.
The use of maXYmos NC allows the inclusion in the program of the pressing speeds and times, which can later be checked, so that we can know if the pressing was carried out under the required conditions, figure 7.

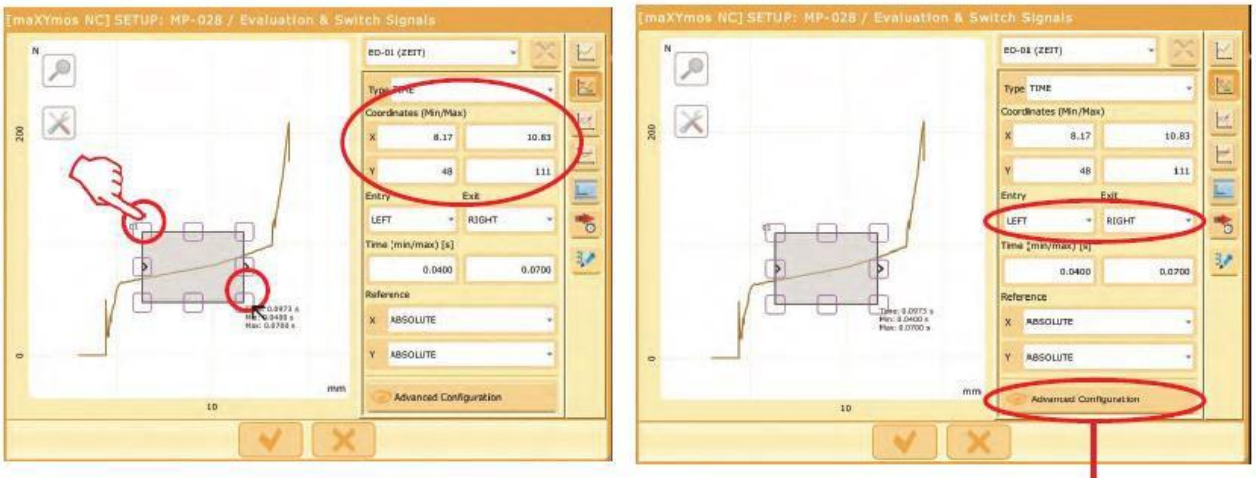

Fig. 7. Screens for entering speed and time parameters

The result of the pressing process is evaluated through the specific windows, in which the system returns the result OK, if a complete movement has been made, that is, the curvature of the curve and its course are in accordance with the tolerance specifications, figure 8. If the press has made an incomplete movement, due workpiece jam, maXYmos makes the decision that the press cycle is NOK, because the maximum press point is reached earlier, which means that the press force has increased far above the preset force graph.

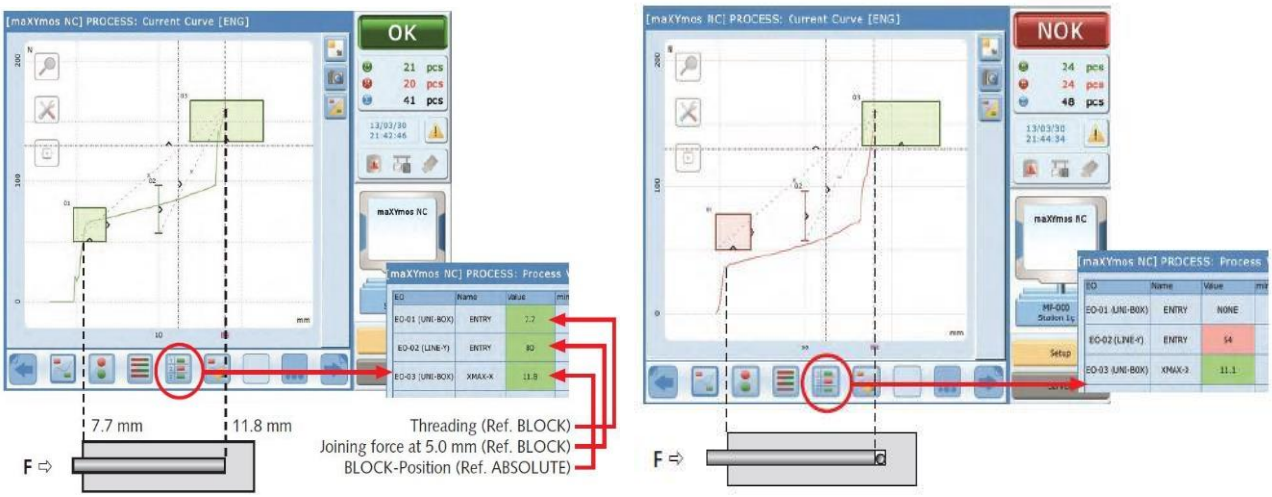

Fig. 8. Screens for entering speed and time parameters

3. Conclusions

The new pressing concept meant major changes both from the point of view of the station's reliability, as well as from the qualitative point of view and from the point of view of the safety of the pressing process.
The analysis of the functionality highlighted the fact that the pressing process was improved.
From the point of view of the maintenance of the installation, the maintenance of the equipment is very easy to do, because the system is a simple constructive one. Preventive maintenance (visual check, greasing, function check) can be performed by maintenance personnel only with the help of instructions and maintenance plans from the equipment supplier.

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