# RESEARCH ON THE CONTROL OF PARTS WITH A CONICAL PROFILE IN PARTS IN THE AUTO INDUSTRY

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*ABSTRACT: The subject of this research paper is the control of conical profile parts. In the beginning it presents the importance of the control of conical profile parts and why they should be very precisely controlled. Then the actual state presents the usage of calibers. After that it shows how the new technologies work, first the inductive probes and second the method using air gages. At the end of that are presented the advantages and disadvantages of all the methods showed before, and the new technologies are both cheaper and more precisely than the old ones. In the end it's written about the way that conical profile parts are tolerated. Finally the conclusions are about how the new technologies are more efficient then the old ones and how they should be used more often because of the fact that the conical profile parts are used in the most important parts of the car.*

*Keywords: pneumatic transducer, probes with inductive coupling, control, gauges*
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## 1. Introduction

This research paper highlights the importance of dimensional control of conical profile parts used in the automotive field. Conical assemblies are widely used in the construction of vehicles, due to their possibilities of self-connection, adjustment of clearances and sealing of the assembly.

Tolerating and sizing, as well as the control of conical parts in the automotive field is very important because they are mainly used in the construction of engines and gearboxes, prone to breakdowns by their nature and by their mode of operation.

The control of parts with a conical profile can be done by different methods such as: control with the help of a sine ruler, control with calibrated balls, rings or rollers, control with a measuring microscope, with the help of pneumatic devices, with the help of gauges or with the help of coupling inductive probes.

They are also characterized by constructive and technological simplicity, as well as by easily performing the assembly and disassembly operations of the component elements.

Conical assemblies aim to fix the relative position of two pieces, both in the radial direction and in the axial direction, creating the tightness or clearance necessary for the assembly.

## 2. The current stage

The existence of such a variety of control methods for parts with a conical profile has made the automotive industry focus on the most efficient methods, both in terms of the time spent to control the part, as well as the precision of the control data. Some of the most effective methods are control with gauges and control with probes with inductive coupling.

The first method is an older one, but it still has great applicability and is very efficient. The control of the internal conical surfaces with the help of gauges is carried out by the axial movement of the gauge relative to the base of the piece to be measured. For this purpose, the gauges are made with two markers, located at a distance of m, one from each other. The distance m represents the frontal distance tolerance (see figure 1).

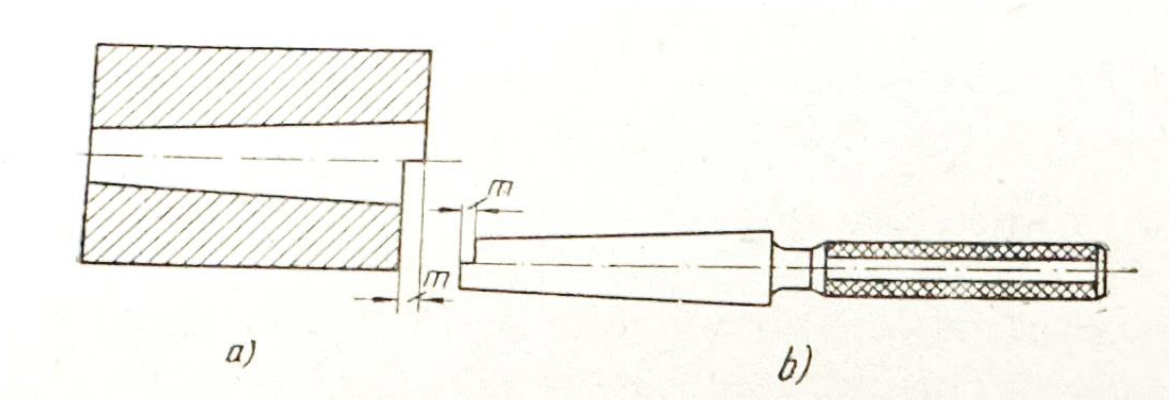


Fig. 1. The distance m [1]

Flat conical bushings are used for the external conical surfaces (see figure 2). The part to be checked rests on some pins. The verification of deviations from conicity is performed by the light slit method between the measuring surfaces of the rulers and the generators of the conical surface. The control is carried out with the help of the marks drawn by the ruler. The control of the thickness and the position of the fixing end of the cone is done with the help of two protrusions, whose surfaces must coincide with the surfaces of the ends of the conical tails of the tools.

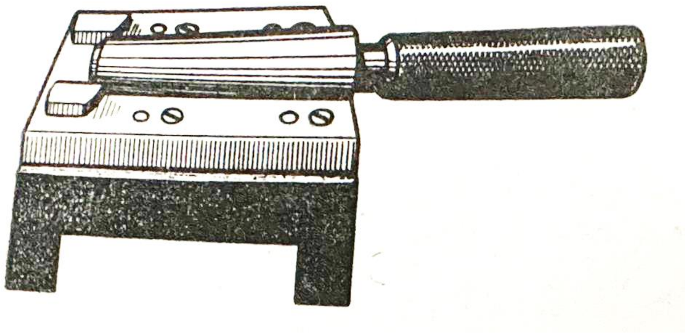

Fig. 2. Flat taper bushings

For more precise measurements and not to be influenced by the human factor as much, electric length measuring instruments were built. The most important factors that were taken into account when building this type of instrument were efficiency, precision and ease of use.

### 3. Digital control methodologies of conicities

The first option is the one that uses probes with inductive coupling (see figure 3 and figure 4). it can be used, however, only for the outer cones. The probes are placed in contact with the part to be measured on the cone generator. They will show the difference in absolute size between the measured values by the other 2 probes.

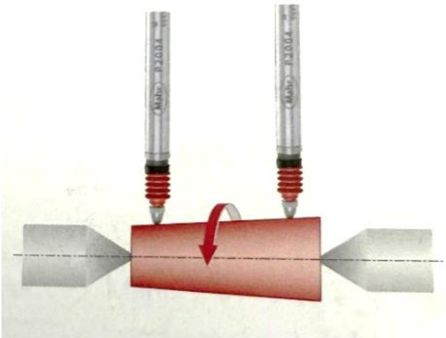


Fig.3. Probes with inductive coupling [2]


Fig.4. Solution of electrical transducers and probes with inductive coupling provided by MAHR [2]

The second version is used to control the internal conical surfaces and is based on the principle of determining the air pressure variation (see figure 5). Thus, a standard part is used, in which the air pressure does not change, and a part in which the air pressure changes. The data collected by the pneumatic transducer will be collected and processed in a graph, from which the deviations of the part will be read and it will be determined whether it is compliant or not (see fig. 7.)

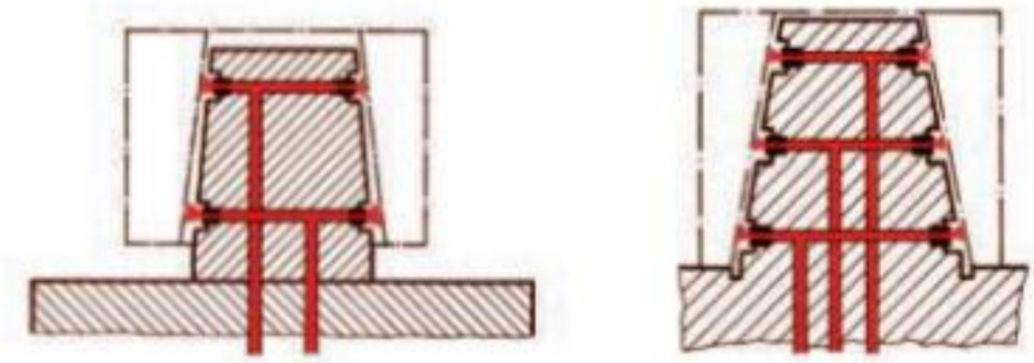

Fig.5 Mounting the pneumatic system on the inner surface of the cone [2]

### 3.1. Methodology of pneumatic measurement of conicities

Using the Millimar control device, it works according to the principle of determining the change in air pressure; the pressure difference between two chambers is measured. As long as there is a constant pressure in one of the two chambers, being the reference pressure, the pressure in the second chamber (measuring chamber) is determined by the distance recorded between the air jet to be measured and the part under test.

The Millimar measuring units (see fig.6) have two connection points that are directly connected to one of the two pressure chambers. Therefore, the measured values are collected directly, without any conversion through a Piezo pressure sensor and then they are digitized. Magnifications from 2500:1 to 10000:1 are achieved with interchangeable heads for air jets.

Millimar measuring instruments must be supplied with air at a constant pressure through a reduction valve. The control units that have a reduction valve can be connected to any kind of compressed air tube between 3.5 bar and 10 bar over pressure. Through which an air filter should be interconnected, because the air that helps to perform the control must be dry and free of traces of oil or other impurities.


Fig. 6. Millimar measuring unit

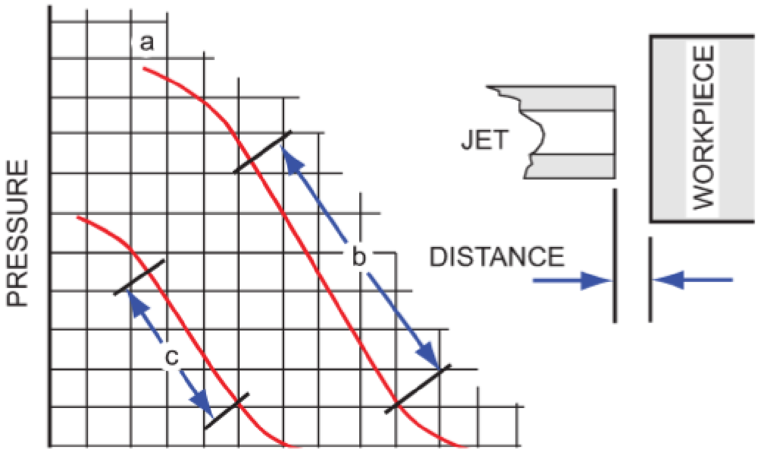


Fig.7 Graph with the pressure-distance measurements obtained from the measurements [2].

## 4. Advantages and disadvantages of the proposed methods

The gauge control method has the advantage of being efficient in terms of time and can be implemented by anyone, regardless of the operator's experience. One of the disadvantages is that this method is expensive, and for parts of different sizes, several gauges will be needed. These are expensive because they must be processed at least with a higher level of precision than that of the part to be controlled.

The control method with probes with inductive coupling has as advantages a very good precision, does not require a long training of the operator and can be used as any type of surface. They are resistant over time and their maintenance is not expensive. In order to be able to function the probes with coupling inductive need a translator. Mahr's translators offer both analogue and digital display as advantages. In addition, they offer a short response time and are ideal for industrial control processes. They can be connected to the computer therefore the data and parts can be evaluated by the computer automatically through various code programs.

The control method with the pneumatic transducer is a method that offers superior precision, the precision varying between 0.5 and 20 micrometers, depending on the designer's requirements. This method is not influenced by external or environmental factors. It is a non-contact method and does not affect the piece in any way. Thanks to their modularity and the ability to be mounted close to each other, they can be used as an entire control system. A final advantage is the resistance they offer over time. The collected data are displayed linearly and clearly, on a larger or longer graph, easy to read and without introducing errors in the final reading. The pneumatic transducer can also be used to control parts with a profile different from the conical one due to the ease and adaptability of the control elements. It offers a wide range of control that can increase up to 10,000 times.

## 5. What is the control of a part with a conical profile

Tolerating parts with a conical profile is done by several methods: tolerating the cone, specifying the conicity, tolerating the cone with the simultaneous definition of the axial position of the cone, tolerating the cone separated from the axial tolerance of the cone, tolerating the cone relative to a reference) simultaneously defining the coaxiality.

In all methods of tolerating cones, the width of the tolerance field of the conical surface is indicated, measured along the normal direction to the conical surface and noted in a tolerance frame in which the graphic symbol of the tolerance for the given shape of the surface is also passed. Any shape deviations of the conical surface must be included in this tolerance field.

With each tolerating method, the other elevations that define the conical surface are included, with the exception of the fourth method in which the axial position of the cone is also tolerated, a position determined by the Lx limit deviations (see fig.8).

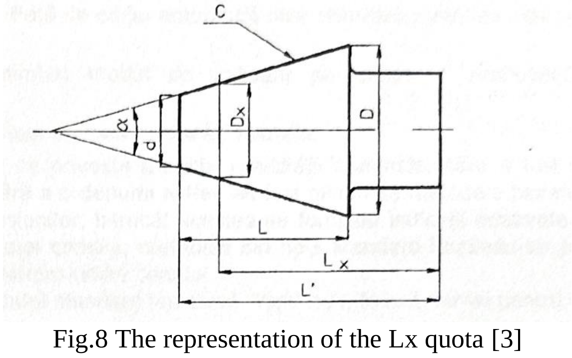


Fig.8 The representation of the Lx quota [3]

There are other methods for tolerating conical surfaces that use only dimensional tolerances, but these methods do not have an adequate indication of the shape of the surface.

Definitions regarding cones, cone sizes and cone angle tolerances are given in STAS. For the tolerances of the cone angle, 12 levels of precision are provided, marked from 1 to 12 in descending order of precision and are applied for tapers from 1:3 to 1:500 and cone lengths from 6 to 630 mm.

## 6. Conclusions

Since the automotive industry is largely based on series production, we will conclude that the most effective methods we can use are those presented in points 2 and 3. These offer both very good precision, requiring minimal training of the operator, being easy to be maintained, and by their nature the time required to control the part is reduced.

Another conclusion would be that in the automotive industry there is a need to control parts with a conical profile, and this should be carried out with as much precision as possible, because the parts with a conical profile are often found in the most important parts of the car, which are also subject to a high level of stress.

## 7. References

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