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THEORETICAL CONSIDERATIONS ON A PORTABLE DEVICE DESIGN FOR KEYWAY SYMMETRY CONTROL OF LARGE HUBS

BY

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Abstract. This article presents some theoretical and practical considerations on the design of portable devices to control the keyway symmetry deviation in this case bore type parts (hubs). The paper present the steps to design a device for the eccentricity keyway control, covering a range of values for hub diameter between 100- 180 mm with some characteristics as the precise materialization of the joint symmetrically plan and the accurate measurement of the symmetry deviation.

Key words: keyway, keyway eccentricity, tenological control devices, schematic diagram, constructive solution.

1. Introduction

To obtain qualitative products and a high level of competitiveness in mechanical engineering, it is necessary to develop an adequate control methodology by choosing the appropriate measurement methods and also an appropriate inspection equipment to ensure an error limit of measurement consistent with tolerance prescribed to measured parameter.

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To choose a control technology that use performance means of measuring may have negative effects on economic efficiency to achieve the benchmarks. Therefore, it requires the use the controls device with the precision adequate to the tolerances set, at least in some stages of processing parts. This would reduce the time and the cost of its control by technological devices that control can be achieved in the preparation of the manufacturing units that produce considered workpieces (Mircea, 2004), (Popa, 2006),(Kosarevsky, 2012).

It is very necessary and widespread the use of portable control devices because one must knew the actual dimensions of the workpiece before removing it from the machine tools were was processed, in order to take the necessary measures so that to bring the actual size between the prescribed limits. Removing heavy parts and their installation in a stationary measurement system lead to unnecessary time consumption, high processing cost and, in many cases, the clamping and the fixing of the remediable parts being hard to do.

The technological portable devices for the dimensional and geometric control for the keyed joint (parallel key or woodruff keys) are special control equipment (Munteanu, 2014), (Cioata, 2009) and are used in medium enterprises, where the acquisition of universal measurement means or modern control equipment becomes unacceptable financially and organizationally point of view.

In mechanical engineering the key joint are used to prevent relative rotation between two parts and may enable torque transmission, so that the precision of this keyway joint is important. This precision depends on the execution precision of the elements that form the keyway joint (shaft- key-hub).

These elements are: the width b of the key, of the keyway in the shaft and the keyway of the hub, the depth of the keyway of the shaft and the hub, the eccentricity keyway of the shaft and the hub, the radial clearance between the shaft and the hub.

The control of these elements that ensures the precision of the keyed joint (haft- key-hub) is achieved by applying several methods that are classified into two distinct categories: verification methods and measurement methods.

In the ideas diagram of Fig. 1 was presented systematized the methods and controls equipments used for checking and measuring the characteristic elements of joints with parallel key and woodruff key.

2. Constructive Solution for a Portable Technological Device

2.1. General Consideration

The keyway joints feathered character is determined by operating conditions and by the fits formed after the width b of the key, of the keyway in the shaft and the keyway of the hub.

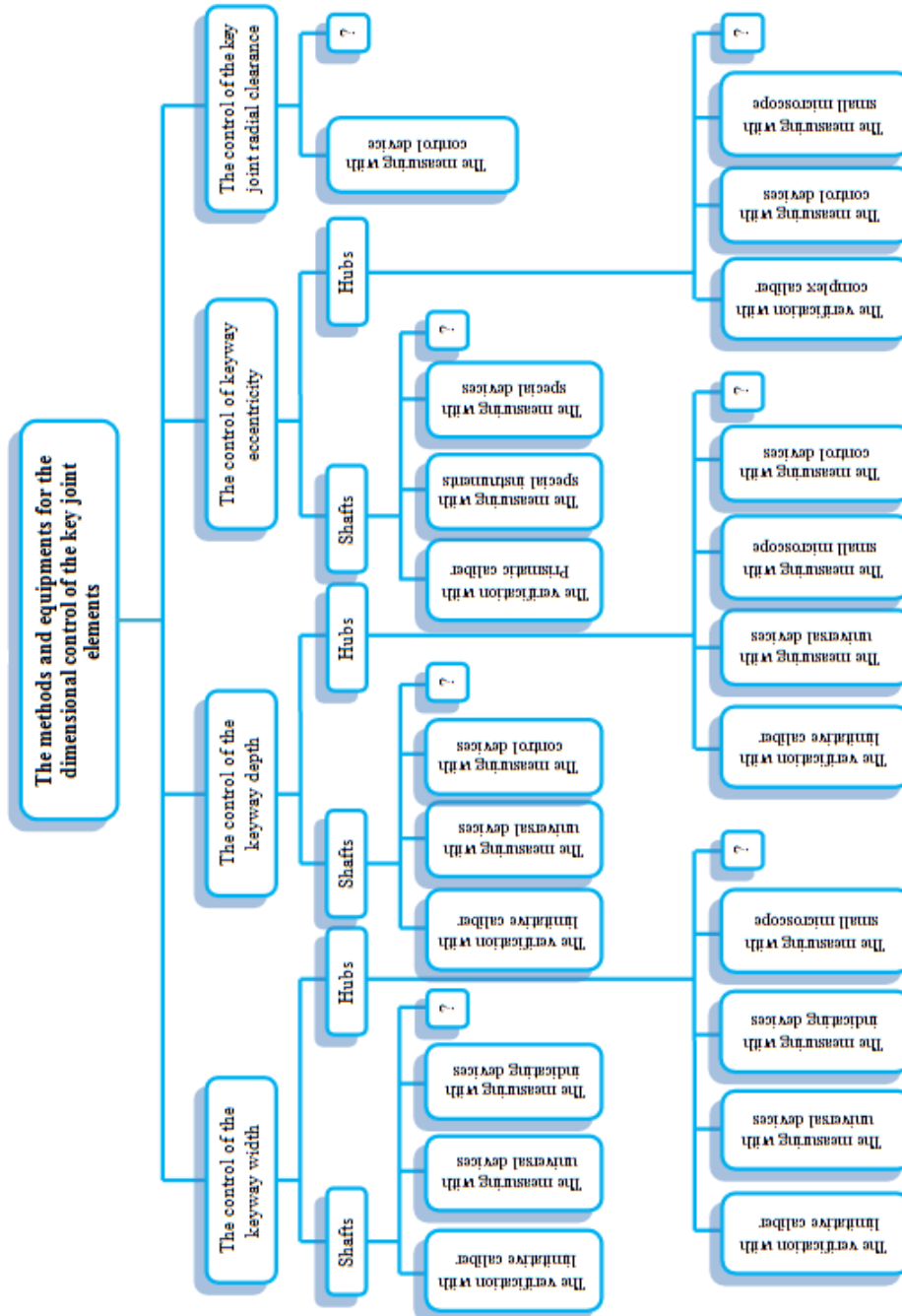


Fig.1 Methods and controls equipments

To achieve the keyed joint shaft - key - hub, one should provide a fit between key and keyway flanks of the shaft and the hub, the width b thereof

Due to the processing errors the keyway from shaft and hub some time are made eccentric toward the axial section of the connection (the symmetry plane of the keyway joint). To make possible the joint its must respect the interchangeability condition.

It is therefore important to know eccentricity and the keyway symmetry deviation from both the shaft and the hub; the control symmetry deviation of the keyway is obtaining through the verification and the measurement.

2.2. Establishing a Schematic Diagram of the Control Device

To establish a method of measuring this parameter, it was considered the definition of deviation from symmetry like the distance between a plane of symmetry of a geometric element and another plane of symmetry specified as the baseline; based on the definition one can identified: the plane of symmetry of the keyway (plane through the center of the keyway width), considered to be tolerated and the plane of symmetry of the keyed joint adopted as the baseline (Fig. 2). Further it is necessary to apply a method to measuring the distance between the two planes of symmetry identified and which should coincide.

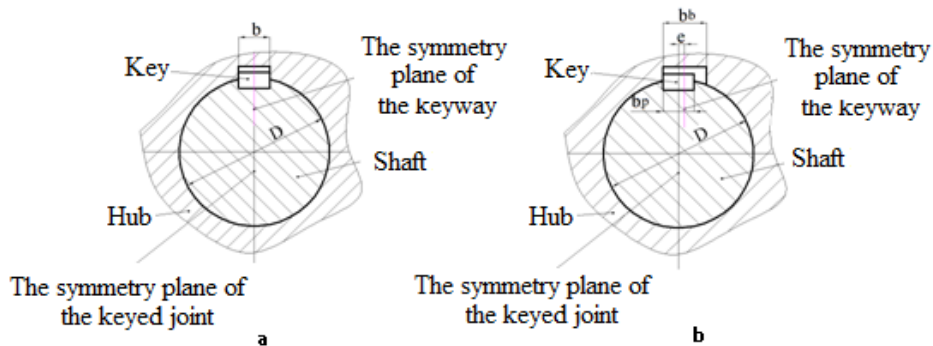


Fig. 2 – The eccentricity of the keyway in the hub

Further it is necessary to apply a method of measuring the distance between the two identified planes of symmetry and which should coincide.

So that, it was considered a method of measuring the keyway symmetry deviation, characterized by the following elements:

- The materialization of the symmetry plane specified as the baseline;
- The materialization of the symmetry plane of the keyway (center plane of the keyway width);
- The measuring the distance between the two planes materialized.

The establishing of a schematic diagram of the control device has been achieved by following a succession of stages based on the identified requirements: E1. Establishing a solution for the orientation control of the device relative to the controlled piece and the positioning of it to measurement; E2. The determination of a solution to measure the eccentricity.

E1. The control solution

It appears that the plane of symmetry of the joint wedge (shaft- key-hub) passes through the bore and shaft common axis and perpendicular to the bottom of the keyway (Fig. 2.2a). For this reason, the materialization of the joint symmetry plane is made in two phases: the adjacent circle to the materialization of a cross section perpendicular to the bottom plane materialization of the keyway.

Because are some processing deviations of keyway made in hub, the plane of symmetry of the keyway not coincides with the plane of symmetry of the joint so that the distance between them is just the eccentricity e , to be measured (Fig. 2.2.b).

The materialization of the adjacent circle of a transverse section is necessary for determining the center of the adjacent circle to the inner cylindrical surfaces of the hub. This is achieved by three probes support (1), spherical type, which are in the same plane and it's in contact with the inner cylindrical surface of the three points distributed over the periphery as (Fig. 2.3.a): probe support 1, is arranged perpendicular to the other two probes 2, 2' and midway between them. So that the center of the adjacent circle to materialize by the probe ball 1, 2, 2' (fitted to the body 3) lies on the axis of the probe 1

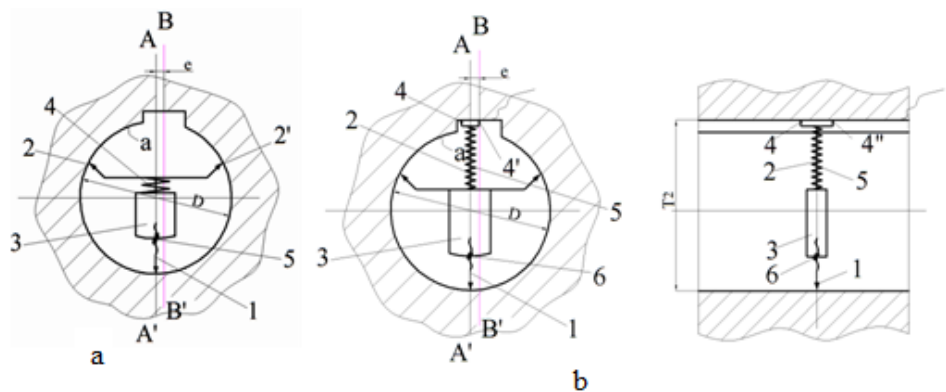


Fig. 2.3 The diagram of adjacent circle and the symmetry plane of the key joint materialization

The permanent contact between the spherical feelers support and the cylindrical inner surface of the hub is provided by helical spring 4. For the materialization

of the adjacent circles of different diameters, probe 1 can be adjusted; the adjustment screw-nut mechanism 5.

The materialization of the perpendicular plane to the keyway bottom is necessary so was established a plane how can pass through the center O, of the adjacent circle of the inner cylindrical surface, but how can be parallel both with the lateral surface c and d of the keyway (fig.2.3.b) for this is used a spherical probe (feeler) 1, how is the same feller support used to materialized the adjacent circle.

3. The Constructive Solution

Based on the schematic diagram of the control device described and knowing the requirements that must satisfy it, it developed a solution of a technological portable device in order to control the deviations from symmetry (the eccentricity) for a hub keyway with the interior diameter in the range 100-180 mm (Fig. 2.4, 2.5).

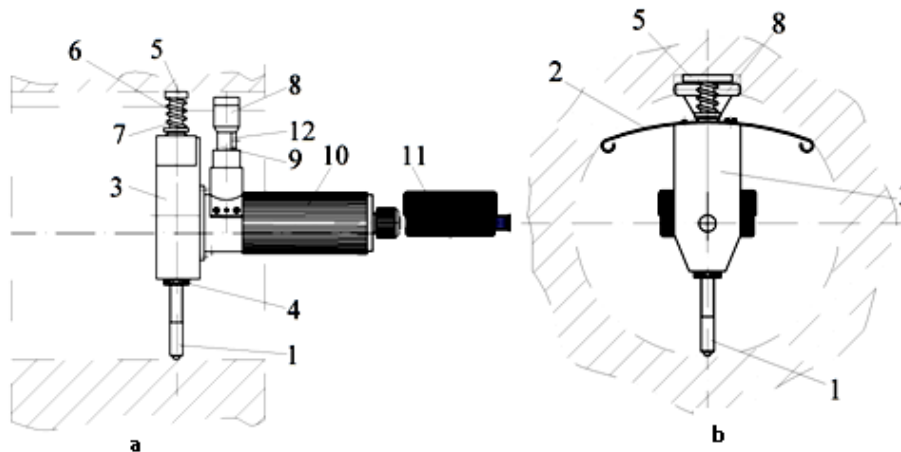


Fig.2.4 Constructive solution for control device

The characteristic aspect for this device is that, being a portable control device all the important components for determining workpieces positioning, orientation and clamping of the device and respectively of the indicating instrument are integrated into a whole, into the body.

It consists of the following separate subassemblies: subassembly of orientation and positioning of the workpiece with respect to the control device, the measuring system and elements and auxiliary mechanisms, all of which are mounted to the body of the device.

The control device is oriented and leaning on the inner cylindrical surface of the hub and on the flat surface of the bottom of the keyway by two mechanisms: a mechanism for centering and a support mechanism (which could be considered a mechanism for indexing).

The mechanism of centering is formed of a feeler support 1 embodying the point of contact and an arm 2, with the ends cylindrical, who materializing in cross-section, other two points of contact. (Fig. 2.4.a and b). The feeler support (1) is a cylindrical rod having at one end like active contact surface a sphere, and at the other end, a threaded surface, which is screwed into the body 3 of the control device and is locked with the nut 4. In this way, it is carried out the continuously adjustment of its length in order to provide a range of different values of hub diameter. Also, in the body of the device can be mounted interchangeable support feelers with different lengths to increase the universality of the control device.

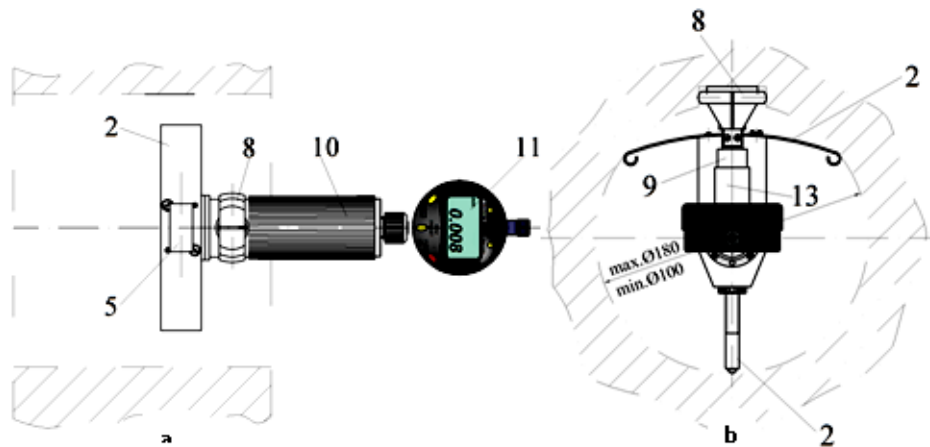


Fig.2.5 Constructive solution for control device

The arm, 2, is a leaf spring with arched and with a rectangular shape, have curved ends with active cylindrical surfaces, at equal distance from the feeler support axis, 1, which provides the adjacent circle materialization with the inner cylindrical surface of the effective diameter of the hub and it is precisely fitted, to the body 3, with centering pins and is bolted with screws. The accurate shape and elastic characteristics of the arm material 2 ensures permanent contact of the mechanism with the inner surface of the hub.

The indexing mechanism serves to guide the control device so that the feeler support axis is perpendicular to the bottom of the keyway and preserve this orientation during the inspection. This mechanism has a simple construction with a element common with the centering mechanism: this is the feeler support, 1, with an active surface like sphere; another element is the sole 5,

mounted by interference fit, to the upper end of the cylindrical shaft 6 coaxial with the probe support 1. The permanent contact of the sole 5, with the flat surface of the base keyway is provided by the helical compression spring 7. The purpose of the assembly of measurement is to measure the eccentricity of plan symmetry of the keyway towards the joint plan and captures the measurement information and transmits this information to the indicating instrument.

The element of capture, the mobile feeler, is an elasticized sleeve, 8, with the active surface profiled (from a torus portion) that comes into contact with the side surfaces of the keyway (Fig. 2.5. a and b). This solution was imposed by the need of direct contact between elements (elasticized sleeve) with both side surfaces of the controlled keyway; because the effective width b_e , the keyway executed may differ from face value (but framed within the tolerance prescribed for this size).

The elasticized sleeve (collet), 8, has a cylindrical zone which is fitted in the inner cylindrical surface of a connecting element 9, which transmits the rotary motion to a shaft (not shown in the figure), which rotates within handle 10 mounted on the body 3. At the handle, 10, is fixed the indicating instrument, 11, whose edge of measurement is in contact with the active front surface (not shown in the figure) mounted on the shaft end. In this way, when the capture item (mobile feeler 8), detects whether there is a keyway eccentricity and execute a tilting movement (one side or the other) that will be converted in axial displacement and sent to the instrument indicator 11.

The mobile feeler (the elasticized sleeve, 8) is interchangeable and can be quickly mounted to the connecting element 9 through a mounting plate 12. In the coaxial position, to the connecting element 9 is mounted on the handle, 10, the stop sleeve 13, with adjusting pins and screws; it fulfills two roles: to protect mobile feeler 8 by limiting its tilting and the as centering element used for zeroing of the device control. The handle 10 has inserted a rubber sleeve, which protects safer handling and thermal control device.

The eccentricity measurement of the keyway is characterized by a series of features regarding the materialization of a rotation adjacent surface and of two planes of symmetry: the plane of symmetry of the joint and the plane of symmetry of the keyway. So that zeroing of the control device is achieved by following a sequence of steps: the materialization of the adjacent area of the hub rotation, the materialization of the joint symmetry and the zeroing the instrument indicator. The main advantage of this device is the fact that the zeroing is not performed on a piece model (which would introduce a significant error setting) but for that is used a measure terminal of length: a specially shape of a bushing caliber, provided with two active surfaces.

4. Conclusions

The dimensional control of the products is a key factor in any technological processing system and is provided by a separate component, but integrated to production system that constitutes the system of control technological. The dimensional control may be performed during the technological process or between the phases and operations, it is an intermediary process control, respectively, after the workpieces processing, the final control.

In this paper has been achieved a theoretical study on the methods and means used to control the dimensional and geometric elements with parallel or disk key connections and it has been identified the control methods of the eccentricity in the hub keyway.

It has developed and designed a portable technological device for the eccentricity keyway control, covering a range of values for hub diameter between 100- 180 mm and having the following characteristics: the precise materialization of the joint symmetrically plan; the accurate measurement of the symmetry deviation for hub keyway, because it uses a indicating instrument with the division of 0.001 mm, which is set at zero with piece model; the ensuring the precision of measurements for the designed device by preserving both the materialization of the adjacent area of rotation and the zeroing of the indicator instrument, during the measurement; the ensuring of fast measurements, time control operation, much lower than when the measurement was performed with an universal or special equipment, portable or stationary;

The schematic diagram of the set was drawn up by the correct completion of a sequence of steps, satisfying such requirements – the relative orientation and positioning of workpieces measured, zero point setting and measurement. This may be an argument for using schematic diagrams regarding the devices for multiple sizes of hubs.

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CONSIDERATII CU PRIVIRE LA ELABORAREA UNEI SOLUȚII
CONSTRUCTIVE DE DISPOZITIV TEHNOLOGIC PORTABIL PENTRU
CONTROLUL ABATERII LA SIMETRIA CANALULUI DE PANĂ LA BUTUCI DE
DIMENSIUNI MARI

(Rezumat)

Acest articol prezintă câteva considerații teoretice și practice privind proiectarea unor dispozitive tehnologice portabile pentru controlul abaterii la simetria canalului de pană la piese tip alezaj (butuci). Pentru lucrarea de fata s-a proiectat o variantă constructiv de dispozitiv tehnologic portabil pentru controlul excentricității canalului de pană, care acoperă un domeniu de valori ale diametrului butucului, între 100 - 180 mm și care prezintă următoarele caracteristici: materializarea precisă a planului de simetrie al îmbinării cu pană; măsurarea precisă a abaterii de la simetria canalului de pană din butuc, asigurarea siguranței măsurărilor prin faptul că, prin varianta constructivă proiectată, se conservă atât materializarea suprafeței adiacente de rotație, cât și reglarea la zero a instrumentului indicator, pe parcursul măsurării, și asigurarea rapidității măsurărilor.