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DEVELOPMENT OF AN AUTOMATED HONING PROCESS CONTROL SYSTEM

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Abstract. This article addresses the issues of increasing the productivity of the honing process during repairs of internal combustion engines. It discusses the main problems encountered during honing on universal machines and proposes ways to solve them. The data on the timing of individual operations of the honing process of engine cylinders are presented. A variant of the system for automatic control of the honing process on universal machines is described.

РАЗРАБОТКА АВТОМАТИЗИРОВАННОЙ СИСТЕМЫ КОНТРОЛЯ ПРОЦЕССА ХОНИНГОВАНИЯ

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Ключевые слова: хонингование, автоматизация, согласование вращений, расчет глубины, проблемы хонингования при ремонте.
Аннотация. Данная статья посвящена вопросам повышения производительности процесса хонингования при ремонте двигателей внутреннего сгорания при осуществлении ремонта. В ней рассматриваются основные проблемы при хонинговании на универсальных станках и способы их решения. Приведены данные хронометрирования отдельных операций процесса хонингования цилиндров двигателей. Описан вариант системы для автоматического контроля процесса хонингования на универсальных станках.

Introduction

Honing is one of the most important processes in the repair of internal combustion engines (ICE). It consists of treating the surface of the engine cylinders to achieve optimum friction and tightness of the piston rings. However, a number of problems can arise in the honing process that can adversely affect the performance and durability of the internal combustion engine. The main honing problems and possible methods of their prevention are discussed in article.

Honing problems on universal machines

Honing quality

– Improper tool selection and machine settings for honing can result in uneven cylinder surface finish, which is bad for pistons and piston rings.

– Insufficient or excessive material removal during honing can result in improper piston-to-cylinder clearance, which in turn can lead to loss of engine power or increased oil consumption.

Cylinder surface preparation

– Cylinder surface instability caused by wear or scratches can lead to uneven honing and improper oil layer formation. This can lead to low compression and oil leakage [1, 2].

– Improper cylinder pre-machining, such as improper finishing to final dimensions or improper cylinder edge grinding angle, can adversely affect the honing process and machining quality.

In series production, the honing process is well established and no special problems arise. In the case of repair production, when changing the cylinder block, the diameter of the bored cylinder is changed, which requires changing the honing tool and adjusting the matching of the vertical and rotational movement of the honing tool so that the scratchs are located at an angle of inclination close to 60 degrees.

During the honing process, in order to control the size, the honing head must be constantly withdrawn from the cylinder to measure the diameter, this procedure must be repeated 3-4 times before the final size is achieved, which significantly increases the time required for this operation.

The metal layer is gradually removed during operation, and the hon bars wear out. The process is monitored according to the readings of the device showing the current of the motor. These readings are not related to the resulting size in any way, and in order to obtain a given size with the necessary tolerance, it is necessary to remove the honing head from the cylinder several times and measure the size of the hole in the part.

Methods to prevent problems

Pre-diagnosing cylinders and preparing them before honing is an important step to prevent problems. This includes measuring cylinder dimensions, determining the surface condition and repairing damage [1, 2, 4].

Correct tool selection and setting of the honing machine ensure a uniform finish on the cylinder surface.

Monitoring the honing depth and material removal prevents cylinders from being improperly finished to final dimensions.

Regular maintenance and monitoring of honing machines helps to prevent possible defects or tool wear.

Proper cylinder preparation and the use of the proper equipment and tools can help prevent these problems and ensure optimal performance of the internal combustion engine.

Let's consider in detail the control of honing depth on the machine 3G833 (Fig. 1) [3].

When honing on this machine, the honing head must be constantly withdrawn from the cylinder and measured to control the size, which greatly increases the machining time. These operations have to be performed 3-4 times until the desired size is obtained.

Data on the time spent on the operation are shown in Table 1.

Fig. 1. Honing machine 3G833

Tab. 1. Data on the time spent on the operation

Operation	Time, sec
1. Measuring the original size	5
2. Honing tool inserting	7
3. Unclamping the bars	8
4. Processing cycle	15
5. Clamping of bars	5
6. Honing tool withdraw	7
7. Measuring the machined cylinder	10

Operations (2, 3, 5, 6, 7) have to be performed 3-4 times before the desired size is obtained. These time costs can be avoided by automating the honing process.

Automation of the honing process control will allow to reduce the total honing time by 60-70% by reducing the unproductive time spent on intermediate control of the dimensions of the processed cylinder.

Development of an automated control system

1. Automatic measurement of the original hole diameter in the workpiece.

Metering must be carried out by contact or non-contact means and transmitted to the control system.

2. Calculation of the depth of the material to be removed.

Based on the measurement results and knowing the original size and the final size, it is easy to calculate the size of the layer of material to be removed.

3. Calculation of the correspondence of the spindle movements.

If the reciprocating speed of the spindle is taken as the basis, then in order to create scratch at the correct angle, it is necessary to calculate the spindle rotation speed.

4. Determining the contact of the bars with the surface of the cylinder.

After inserting the hon into the cylinder, it is necessary to unclamp the bars until they come into contact with the surface of the cylinder, at the same time it is necessary to fix the moment of contact, this can be done with the help of the load indicator installed on the machine, the load value will increase sharply at contact. Further, knowing the size of the layer to be removed, it is possible to calculate the number of pulses for the stepper motor installed on the drive of the unclamping bars.

5. Constant load maintenance system.

The control system (Fig. 2), when fixing the load reduction, must supply pulses to the stepper motor. Thus, maintaining the load until the final size is obtained.

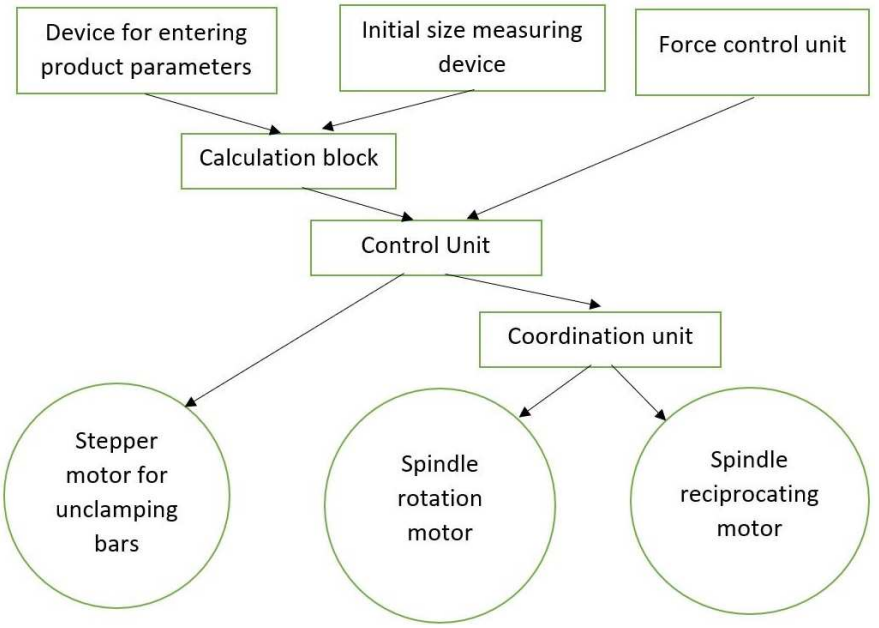

Fig. 2. Scheme of operation of the automatic control system

Description of system operation

Using the input device, the operator sets the final diameter of the cylinder and the data on the angle of cut on the cylinder.

With the help of a measuring device for the initial diameter of the cylinder is measured before processing. All data is transmitted to the calculation unit in which the cutting depth is calculated and the necessary coordination of rotation and reciprocating motion of the spindle is performed. The data from the calculation unit is sent to the control unit, which transmits the data to the Coordination unit.

Next, the control unit starts controlling the stepper for unclamping bars until a signal appears from the force control device. This moment is considered the beginning of processing and the beginning of the countdown for unclamping the bars.

Further, the control unit, based on signals from the force control unit and the calculated cutting depth, controls the stepper motor for unclamping the bars and conducts processing until the final cylinder diameter is reached.

When the final diameter of the cylinder is reached, the control unit gives the command to complete the processing.

In order to perform the above actions, a project for the modernization of the shooting machine was developed, including a measuring head, an upgraded honing head and a control system.

An upgraded system for unclamping bars driven by a stepper motor is shown in fig. 3.

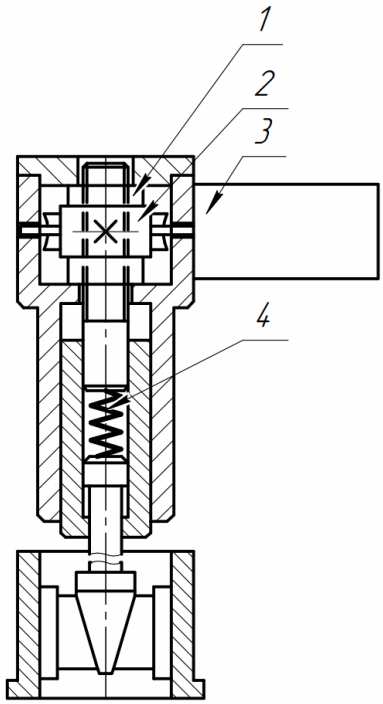

Fig. 3. Modernised bar unclamping system:
1 – nut, 2 – worm gear, 3 – stepper motor, 4 – spring

Conclusion

This automated honing control system will significantly improve cylinder machining accuracy and reduce process time. This will avoid incorrect cylinder finishing and improve the efficiency of internal combustion engine overhaul.

The use of an automated system will increase the productivity of the honing process by approximately 60-70%.

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