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### SECTION 7. Mechanics and machine construction.

## SPECIAL TOOLING FOR MANUFACTURING OF AUTOMOTIVE COMPONENTS: PROCESSING TECHNOLOGY OF THE PART "INSERT" AND ASSEMBLY OF A MOLD FOR INJECTION MOLDING

**Abstract:** Technological process of manufacturing of the forming part "Insert" and assembly of a mold for injection molding of the part "Wiper arm cap" are presented in the article. Attention is paid to description of recommended technological equipment, tooling, and methods of mechanical machining, electrical discharge machining and heat treatment of a workpiece.

**Key words:** a workpiece, a machine tool, operation, a part.

**Language:** English

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### Introduction

Mass manufacturing of secondary parts of a car (mainly made of plastic) is carried out by casting into special molds. Manufacturing process of the mold for injection molding is time-consuming and it is included of a number of technological stages: the mold design, the parts manufacturing of the mold, assembly and the mold testing. The forming parts of

the mold demand a special manufacturing accuracy. The part "Insert" is used for formation of fitment hole in a wiper arm cap in the cars of "UralAZ" [1]. The wiper arm is fastened by a nut to a shaft of the wiper mechanism. This nut is closed by the black plastic cap of almost square shape.

General view of the wiper arm cap for the cars of "UralAZ" is presented in the Fig. 1.



Figure 1 – General view of the wiper arm cap for the cars of "UralAZ".

The part "Wiper arm cap" is made by injection molding from polyamide PA6-GF30 modified by addition of 30% glass fiber. Addition of glass fiber significantly increases hardness, rigidity and wear resistance of the part. Polyamide PA6-GF30 is used for manufacturing of the parts operating at elevated temperatures and significant mechanical loads.

Processing features of the forming parts of the mold and the mold assembly for injection molding of the part "Wiper arm cap" it is possible to present after the analysis of all stages of production process of manufacturing of the considered automotive component.

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### Processing technology of the part "Insert" and assembly of the mold

Processing technology of the part "Insert" contains mechanical machining, electrical discharge machining (EDM) and heat treatment. Four forming

parts of the mold for injection molding are made from one workpiece.

The drawing of the workpiece with an inscribed contour of the part "Insert" is presented in the Fig. 2.

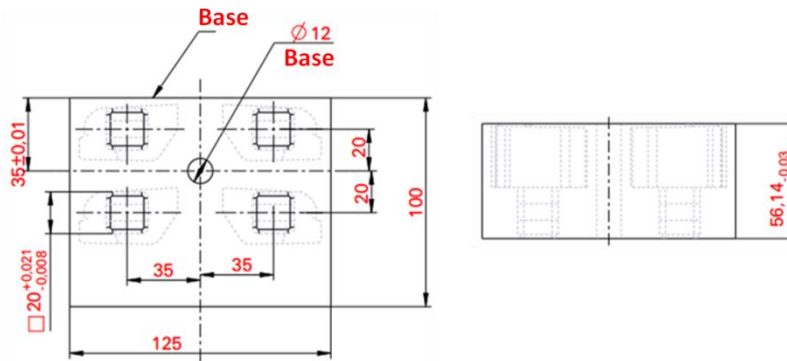


Figure 2 – The workpiece with inscribed contour of the part "Insert".

Die tool steel X37CrMoV5-1 is adopted by the workpiece material [2].

Technological process of manufacturing of the part "Insert" and assembly of the mold for injection molding are presented in the Fig. 3 – 15.



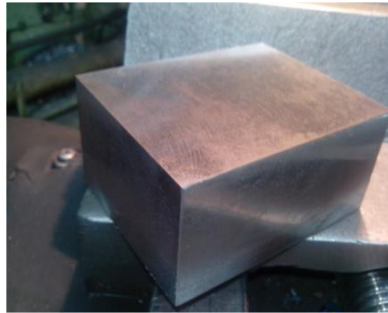
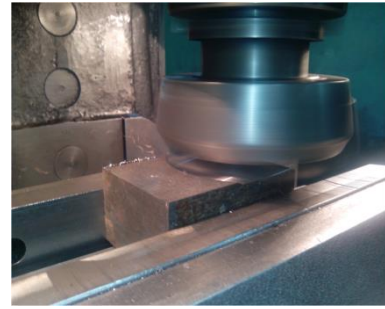
Figure 3 – The blanking operation.

A plate is accepted as the workpiece. Cutting of the workpiece is carried out on the band saw "PEGAS" with allowance for overall dimensions of 5 mm [3]. The workpiece is processed on subsequent operations by means of metal-cutting and electrical discharge equipment.

The workpiece processing is carried out on six sides (allowance for grinding of 1.5 mm) on the milling operation. For milling of the workpiece is used milling machine "WM121M". The workpiece is mounted and clamped in a milling vise. A high-speed milling head with interchangeable carbide cutters is used as a cutting tool.

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**Figure 4 – The milling operation.**

The workpiece is grinded on six sides with allowance of 0.8 mm in angle of 90° on the profile grinding operation. Grinding is a necessary condition for the accurate workpiece locating on subsequent technological operations. Abrasive processing is

carried out by a grinding wheel (the grain size of 2000) on the grinding machine "3L722A" [4]. Clamping of the workpiece is performed by a magnetic holding plate.



**Figure 5 – The profile grinding operation.**

The workpiece locating on the CNC (Computer Numeric Control) milling operation is performed from overall dimensions. Allowance for processing is divided evenly on the sides. The size ledges of 20×20 mm with allowance of 0.8 mm are milled. Chamfers processing is performed completely subject to

allowance. Machining is carried out on the machine tool "FADAL VMC-3016HT" [5]. Locating and clamping of the workpiece are performed in the milling vise. The cutting tool is the milling cutter with the diameter of 20 mm with interchangeable carbide inserts.

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**Figure 6 – The CNC milling operation.**

Machining of the number of through holes is carried out on the coordinate boring operation. Machining is carried out on the coordinate boring machine "2N135" [6]. The workpiece is clamped in the milling vise. Allowance for processing is divided evenly on the sides.

The central hole with the diameter of 12 mm is pre-processed by the twist drill with the diameter of

11 mm and then it is bored to final size. The hole is necessary for binding and insertion of wire with allowance of 0.5 mm.

Machining of four holes with the diameter of 3 mm for insertion of wire (cross section of 0.25 mm) according to the drawing is performed in the ledges of the workpiece.



**Figure 7 – The coordinate boring operation.**

Heat treatment (hardening) is carried out in the vacuum furnace "RHEV-5.5/11.5 E2" [7]. Hardening is performed according to the part drawing at observance of the following modes: the workpiece exposure two hours at 1000 °C; moving of the workpiece from a hot chamber to a cooling chamber;

cooling of the workpiece to a temperature of 600 °C; removing of the workpiece from the furnace and complete air cooling; hardness measuring of the workpiece material (48...52 HRC); tempering of the workpiece in the vacuum furnace at the temperature of 400 °C during 2 to 3 hours.



**Figure 8 – The thermal operation.**

Grinding of the workpiece completely in the size of 56.14 mm and four surfaces (reference plane) are performed on the grinding operations (on the figures are not shown). Equipment (the grinding

machine "3L722A"), tooling (the magnetic holding plate) and the cutting tool (the grinding wheel) are used for processing.

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Final boring of the hole with the diameter of 12 mm at maintenance of the size of 35 mm is performed on the coordinate boring operation (on the figures are not shown).

The workpiece is placed concerning to the hole (the diameter of 12 mm) in the profile grinding

operation. The ledges are grinded completely by the grinding wheel (the grain size of 2500) in the size 20×20 mm at maintenance of height and center distances according to the drawing. The grinding machine "3L722A" and the magnetic holding plate are used for processing.

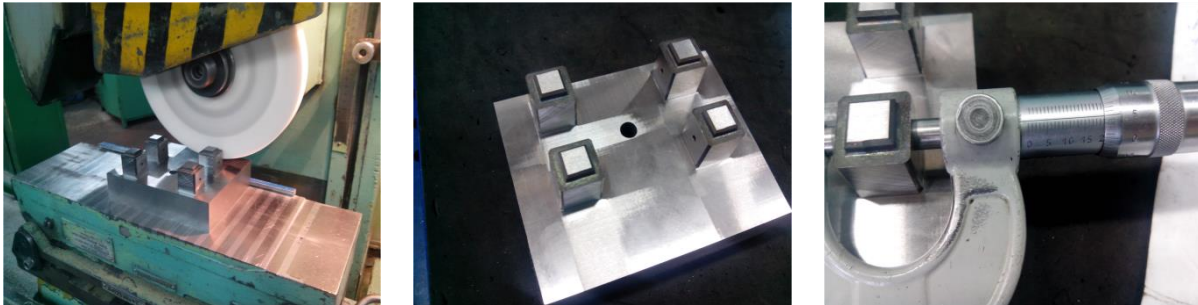


Figure 9 – The profile grinding operation.

The workpiece locating on the electric spark operation is remained from the previous operation. An outer profile of the parts according to a trajectory obtained from a three-dimensional model of the part

is cut out by brass wire (cross section of 0.25 mm). Technological equipment is the electric spark machine "SODICK AQ325L" [8].

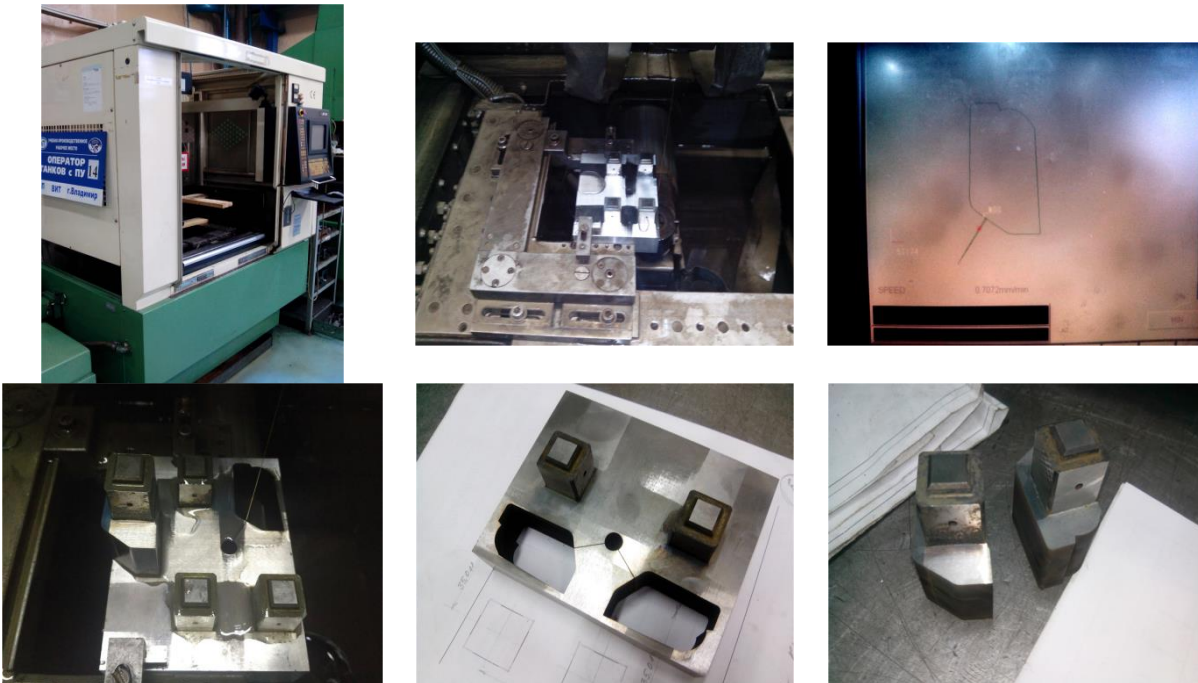


Figure 10 – The electric spark operation.

Fitting of the outer contour of the part with the contours of dies for ensuring of sliding fit is performed on the locksmith operation. The parts with

engines are assembled concerning to the forming profile.

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Figure 11 – The locksmith operation.

The hole with the diameter of 8 mm in the parts and the engines in assembly is cut out on the electric spark operation. The electric spark machine

"AgieCharmilles CUT 20" is used [9]. The tool is brass wire by cross section of 0.25 mm.

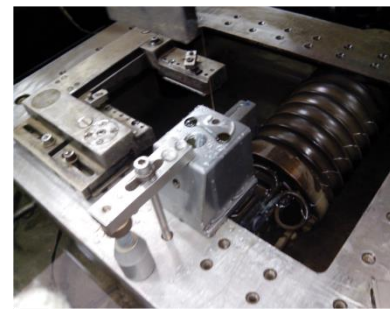
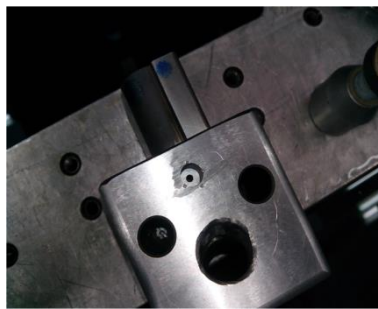


Figure 12 – The electric spark operation.

Assembly of the parts on pins is performed on the locksmith operation.

Burning of the forming profile of the part by a special copper electrode, pre-made on the CNC milling operation, for obtaining decrease with fillet

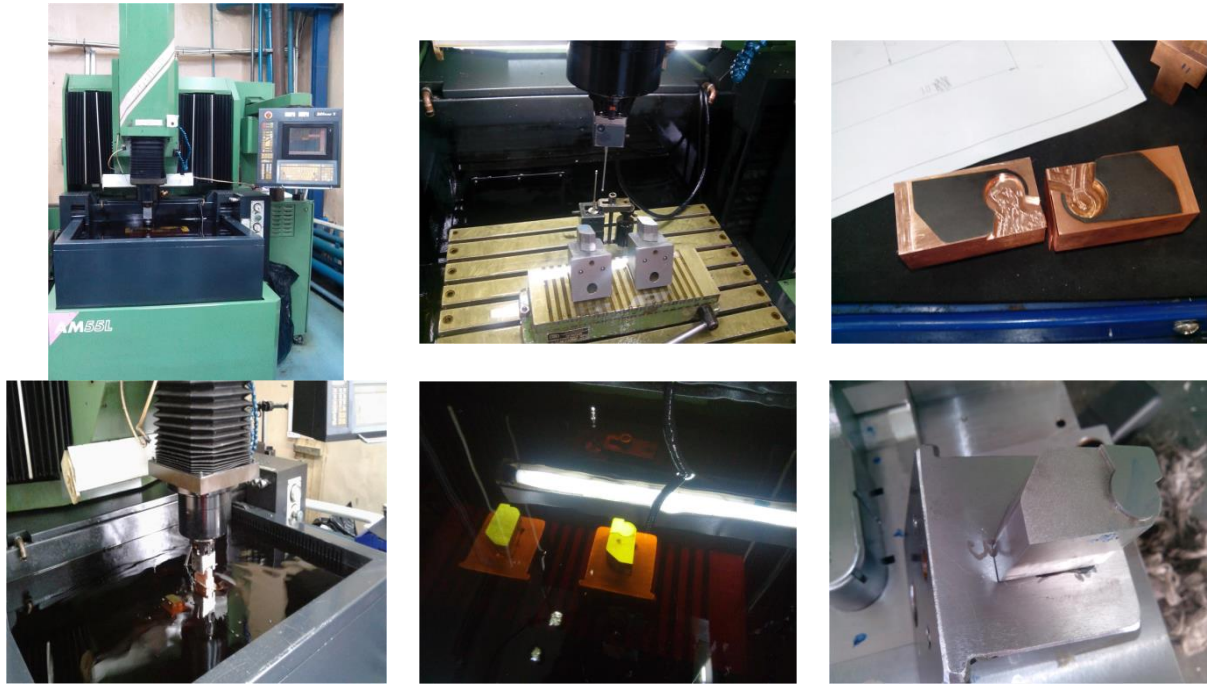
and the matte surface is performed on the EDM operation. The machine "SODICK AM55L" is used as technological equipment. The parts in assembly are clamped by means of the magnetic holding plate.



Figure 13 – The locksmith operation.

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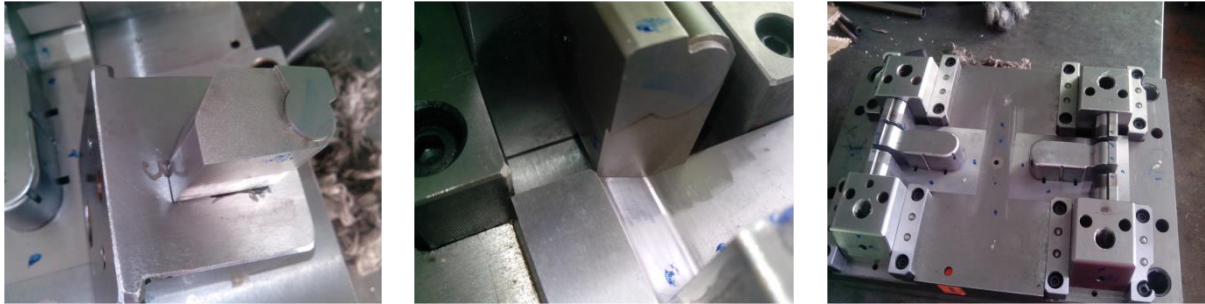
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**Figure 14 – The EDM operation.**

The profile lapping of the part "Insert" to the die and assembly of the mold for injection molding

are performed on the locksmith operation. Two wiper arm caps are simultaneously pour in the mold.



**Figure 15 – The locksmith operation.**

Processing of the accepted workpiece by this technology is allowed to obtain the complex contour of the parts "Insert". Technical requirements for manufacturing of the part "Insert" are provided at use of high-precision equipment on the responsible operations of technological process.

**Conclusion**

Thus, technological process of manufacturing of the forming part of the mold for injection molding

consists of 14 main operations. Responsible elements of the part "Insert" are processed on the last operations of technological process by the three-dimensional solid model pre-created by the technologist and loaded into special software of the special machines. This technological process of manufacturing of the automotive component for the cars of "UralAZ" is implemented on production areas of JSC "Plant "Avtopribor", Vladimir, Russia.

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