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DESIGNING AND MANUFACTURING OF SHAPING PARTS OF A DIE MOLD

Abstract: Manufacturing stages of a die mold were considered in the article. Attention was paid to computer designing and subsequent manufacturing of the die mold shaping parts and tools of the second order (copper electrodes).

Key words: a die mold, an insert, designing, machining, an operation, a machine.

Language: English

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Introduction

A die mold consists of many groups of parts, each of which performs its a specific technological function. The parts group of the die mold, responsible

for shaping of a casting, is the most complex and time-consuming. This group of the parts is 70% of cost of the entire die mold. High requirements for accuracy, physical and mechanical properties, surfaces

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roughness and manufacturability are imposed to the parts [1 – 10]. Designing stages and production of the shaping parts of the die mold are considered in this article.

Technological part

The designed die mold consists of two inserts (upper and lower), the cylindrical signs (the rods) and the rectangular signs (the inserts). Cavities of gating channels and the shaping cavities are performed on the

inserts. The channels for melt injection into the shaping cavities of the die mold are performed in the lower insert. The minimum diameter of the conical channel for melt injection is 0.6 mm. The inserts are made of 1.2379 (EN) steel. Material hardness of the lower and upper inserts after heat treatment should be 58...62 HRC. Four castings are simultaneously poured into the die mold. The three-dimensional solid model of the die mold is presented in the Fig. 1.

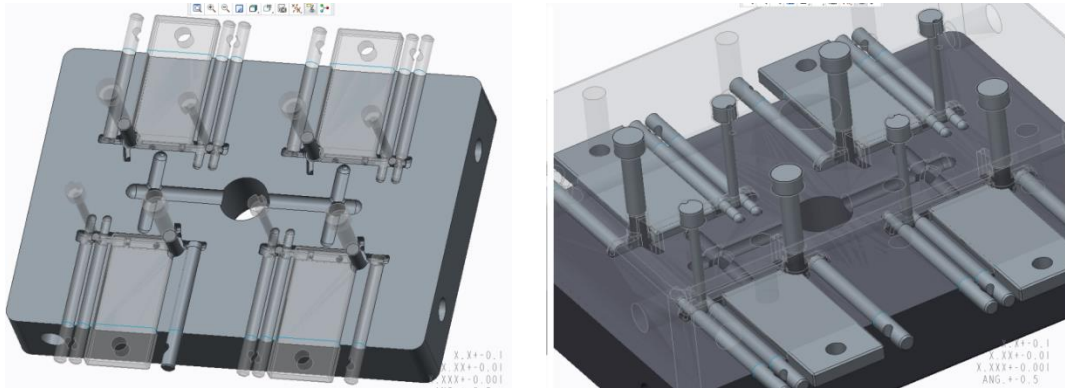


Figure 1 – The three-dimensional solid models of the die mold parts in assembly.

The cylindrical and rectangular signs are placed in the shaping cavities of the upper and lower inserts. These signs form the outer and inner surfaces of the casting. Roughness of the contact surfaces of the rods should be 0.32...2.5 μm . The signs are made of 1.2108 (EN) steel. Hardness of the signs material is 49...53

HRC. Roughness of the contact surfaces of the rectangular sign should be 0.63...1.25 μm .

The three-dimensional solid models of the shaping signs of the die mold are presented in the Fig. 2.

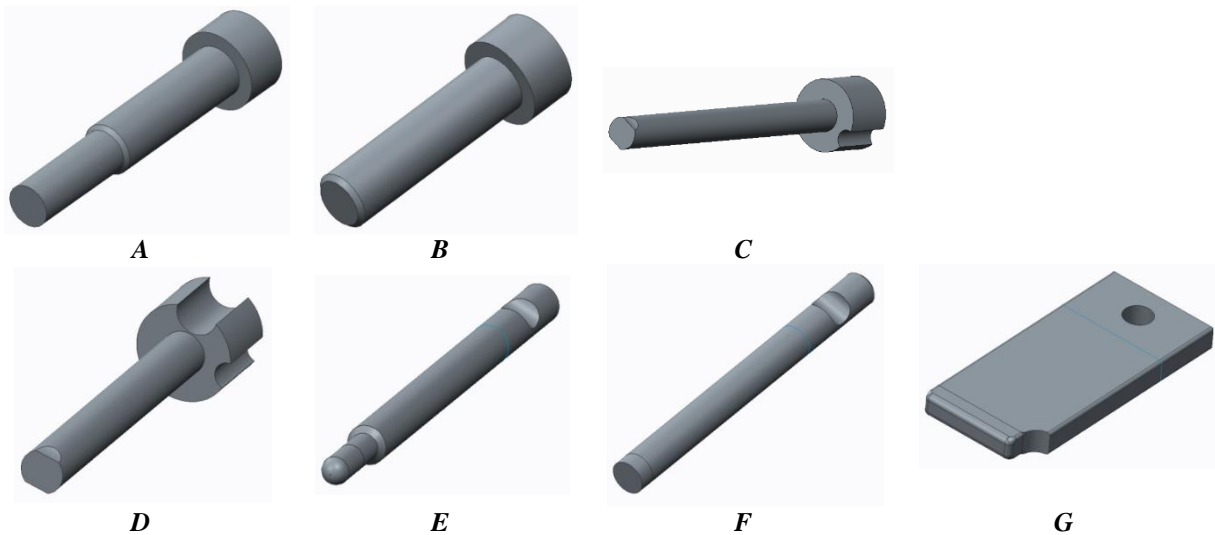


Figure 2 – The three-dimensional solid models of the cylindrical and rectangular signs:
A – F – the rods; G – the insert.

Operations of a technological process of manufacturing of the main shaping parts of the die mold are described in the table 1. The technological process consists of 13 operations. Processing is

carried out on the universal machines and on the machines with numerical control. Grinding is carried out by a grinding wheel (graininess – 2000).

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Table 1. The processing technology of the parts "Insert".

The operation	The operation description	The equipment
Blanking	Cutting of a billet with allowances of 2.5 mm on a side.	The band saw "Pegas"
Milling	Milling of the billet with six sides with allowance of 1.25 mm on the side.	The milling machine "WM121M"
Grinding	Grinding of the billet with six sides to the angle of 90° with allowance of 0.4 mm on the side.	The grinding machine "3L722A"
Coordinate boring	Drilling and boring of holes for the signs, the ejectors and the gate bushing; drilling of the holes for fastener.	The coordinate boring machine "2N135"
Locksmithing	Drilling of the holes for threads and the cooling channels; threading according to a drawing.	
Coordinate milling	Milling of the shaping cavities and the cavities for the signs, the gating channels, the retainer of the gate bushing and the technological holes for the pins previously with allowance of 0.4 mm on the side, fillets on the corners completely.	The machining center "C-tek KM 80"
Thermal	Hardening of the billet according to the drawing up to 58...62 HRC. The heat treatment modes: holding 4 hours in coal at the temperature of 1000 °C, cooling with oil, tempering 3 hours at the temperature of 250 °C.	
Grinding	Grinding of the billet with six sides to the angle of 90° with allowance of 0.1 mm on the side.	The grinding machine "3L722A"
Coordinate boring	Boring of the technological holes for the pins completely.	The coordinate boring machine "2N135"
Coordinate milling	Milling of the gating channels, the cavities for the signs, the cavities for the rectangular signs completely, the shaping cavities preliminary with allowance of 0.1 mm on the side for performing of the electrical discharge operation.	The machining center "C-tek KM 80"
Grinding	Grinding of the insert in assembly on the pins with four sides completely according to the drawing; allowance is distributed evenly.	The grinding machine "3L722A"
Electrical discharge	Burning of the inserts by special electrodes. The channels for injection in the gating channels, the shaping cavities, three shaping grooves are burned on the insert "08". Permissible roughness in accordance with the sample No. 28. The shaping cavities are burned by the special electrodes on the insert "09".	The EDM "SODICK AM55L"
Electrical discharge	Burning of the cavities for the cylindrical signs by the special electrodes in the inserts in assembly. The inserts "08" and "09" are assembled on the pins for achieving of the highest accuracy of the cavities.	The EDM "SODICK AM55L"

Designing of mechanical and electrical discharge processing of the shaping surfaces on the parts of the die mold in the *PTC Creo* software environment is presented in the Fig. 3. Final processing of the gating channels and preliminary processing of the shaping cavities in the inserts are carried out by milling. Machining is carried out by the three-dimensional model of the part. A trajectory of a

cutting tool is presented by red lines. The tools of the second order (the special copper electrodes) must be processed for final processing of the inserts on the EDM machine. The electrodes are processed in parallel to manufacturing of the inserts. The shaping cavity of the insert is processed by the first electrode. Three grooves are processed by the second electrode.

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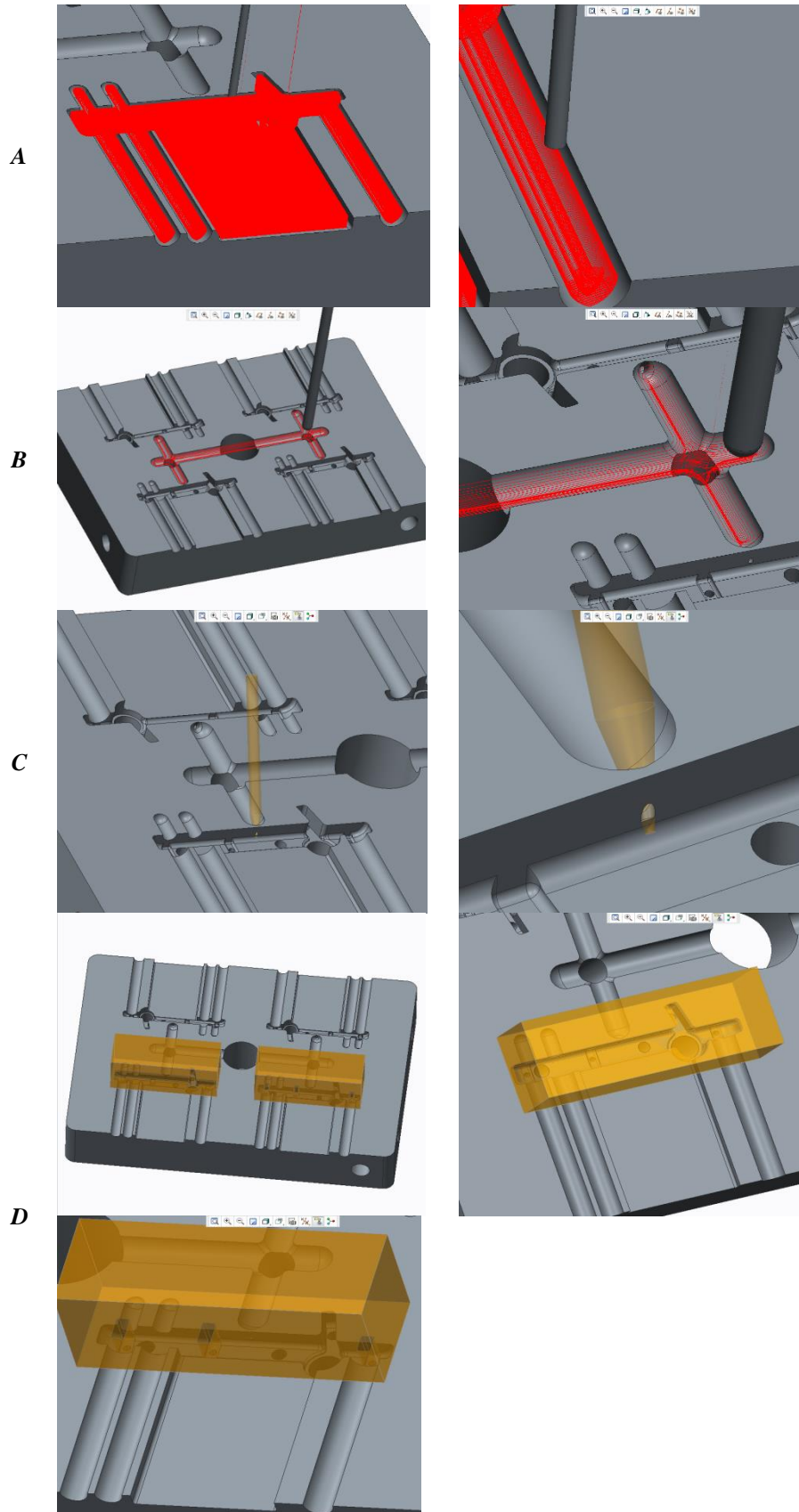


Figure 3 – Processing designing of the shaping surfaces: *A* – the cavities for the cylindrical and rectangular signs; *B* – the gating channels; *C* – the channels for melt injection in the gating channels; *D* – the shaping cavities and three grooves.

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The some operations of the technological process of manufacturing of the die mold are shown in the Fig. 4. The main operation of obtaining of the gating channels and the shaping cavities of the insert

is presented in the photos of *A* and *B*. The photos of *C* – *G* demonstrate the manufacturing process of the tools of the second order. The rectangular signs are processed in the photos of *H* and *I*.

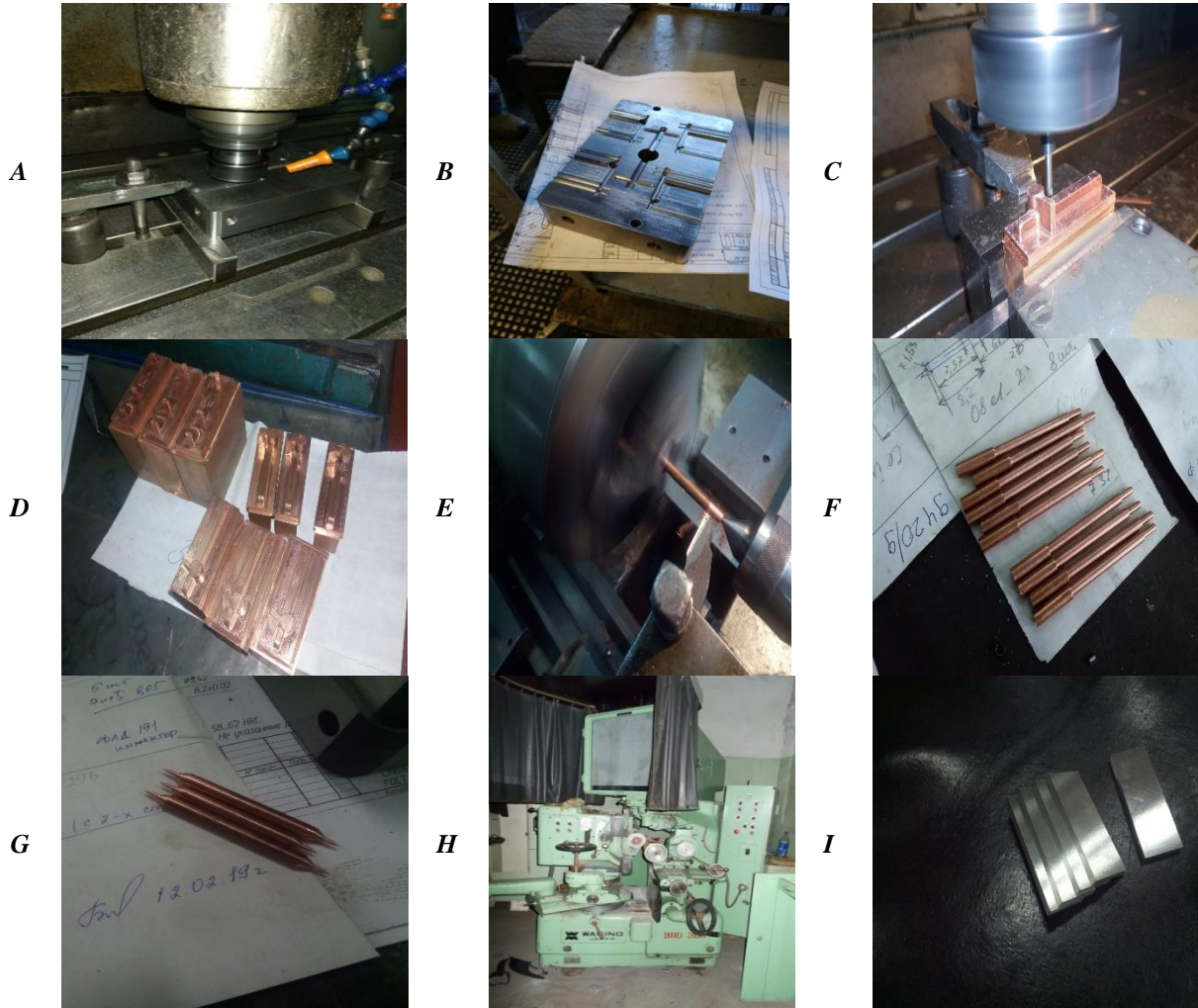


Figure 4 – The operations of the technological process of manufacturing of the die mold: *A* – milling of the gating channels and the cavities for the signs; *B* – the billet after milling; *C* – a profile milling of the copper electrode for burning of the cavities for the signs; *D* – the processed copper electrodes; *E* – turning of the cylindrical electrodes; *F* and *G* – the processed cylindrical electrodes; *H* – the machine "GLS-125a WASINO" for optical grinding; *I* – the billets of the rectangular signs after grinding.

The cylindrical signs are processed on the following technological equipment:

A. The lathe "16K20". Turning of a contour with allowance of 0.8 mm.

B. A furnace. Hardening of the signs according to the drawing. The heat treatment modes: holding 20 minutes at the temperature of 850 °C, cooling in oil, tempering one hour at the temperature of 500 °C, air cooling.

C. The grinding machine "Karstens AS 15 A". Grinding of the signs in a size.

D. The optical grinding machine "GLS-125a WASINO". Grinding of the cylindrical grooves and slopes on the signs according to the drawing.

The designed three-dimensional solid model of the casting is presented in the Fig. 5.

The casting is made of MIM 4140 alloy. A volume of the casting material is designed with shrinkage of 18%. The casting slopes are performed in direction of reducing of the sizes. The ejector marks with the depth of not more than 0.1 mm are allowed on the some casting surfaces.

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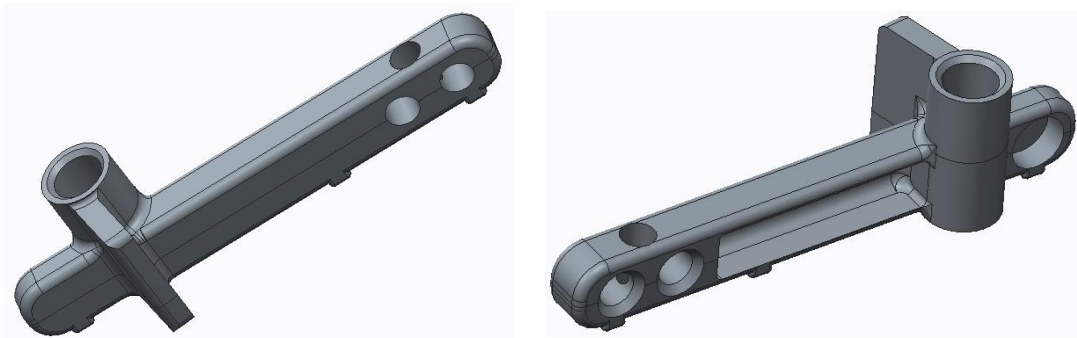


Figure 5 – The three-dimensional solid model of the casting.

The assembled die mold is subjected to mechanical finishing and testing under the different operating conditions for obtaining of the best results after manufacturing of all the parts.

Conclusion

Designing of the shaping parts of the die mold includes the development and manufacturing of the

tools of the second order for sequential processing of the shaping surfaces. The complex shaping surface on the inserts is processed by means of the rough, semi-finishing and finishing profile electrodes. Configuration and orientation of the cylindrical and rectangular signs in the inserts are presented.

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