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Design of a Mould Block for Polymer Optical Disks Substrates

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Abstract: *A design of the mould block for optical disks is proposed, including a packet of plates, elements and subsystems, forming the moving and fixed half of the mould block. It enables the multivariance of the construction solutions of the system creating the central hole of the polymer substrate, as well as of the elements forming the substrate periphery. The exact and precise centering between the fixed and moving half is a prerequisiste for obtaining a substrate with high criteria concerning the concentricity between the central hole and the outer diameter and the surfaces parallelity.*

Keywords: *optical disks substrates, mould block, substrate central hole.*

The rapid advance of technology and production of optical disks influences considerably all the aspects of this new industry. The great speed of technology expansion and the increase of the risk caused by complications or concept evaluation is a process that has many mutually connected components and purposes [1]. In other words, the technical progress in this field is not completed yet [2, 3]. The requirements for improved dimension accuracy and stable shaping, as well as for high precise optical characteristics of the optical disks substrates have implied the notion precise moulding. [4, 5]. The moulding of optical disks substrates on the basis of injection moulding or its modifications is regarded as the most precise moulding type at the present moment [6]. A proof for this can be seen in Table 1, which shows tendency for increasing the dimension precision in the production of mould blocks for different kinds of articles [7, 8].

Table 1

Article	Accuracy of mould production, μm
Lenses and prisms	1 upto 5
Precise prisms	0.25 upto 0.50
Flat-parallel plates	0.05
Optical disks	0.005

The experience in injection moulding of optical disks substrates gained up to now shows that the mould block occupies a central position and is the most important part in the production process. The obtaining of the geometrically simple polymer substrate, representing a circle pulley 1.2 mm thick, with a diameter of the central hole 15 mm and outer diameter – 120 mm, together with the requirements for precise copying of the information structure by a stamper, placed in the mould block, as well as dimension accuracy and low birefringence, set high requirements towards the mould form [9, 10]:

– precise copying of the geometric dimensions of the substrate and especially of the information structure;

– evenness of the temperature field of the mould block;

– reliable attachment of the stamper to the mould block with a possibility for quick and easy replacement;

– deaeration of the mould block with the possibility to apply compressed air to the cavity;

– precise formation of the substrate central hole;

– secure separation of the product from the mould block;

– reliable system for centering of the moving and fixed half of the mould block.

All these requirements implicate precise design and manufacturing of the mould block with tolerances of the order of microns [1, 7].

When analyzing the constructions of some known mould blocks for optical disks substrates, it becomes obvious that the most significant part of the mould block is the main block, consisting of a moving and a fixed half, forming the cavity of the mould form in-between [7].

Fig. 1 shows a diagram of the basic block of the mould for polymer substrates of optical disks of Netstal company [11]. The centering of the moving and fixed half with the help of the conal surface "A" and two guide pins and guide bushes is typical for the mould block. The attachment of the stamper to the mirror insert 7 is realized by a conal gear unit, moving the stamper holder bush along the axis of the mould block. Another characteristic element is the venting ring 10, forming the periphery of the substrate and contacting frontally with the stamper. The movement of the system for configuration of the central hole in the substrate is realized with the help of a hydraulic cylinder 2, fixed to the rear plate 3 of the mould block.

Fig. 2 shows the mould block of Craus Maffay company, in which the centering of the fixed and moving half of the mould block is realized by the conal surfaces of the mirror insert 11 in the moving half and the mounting plate 20 in the fixed half of the mould block [12]. The

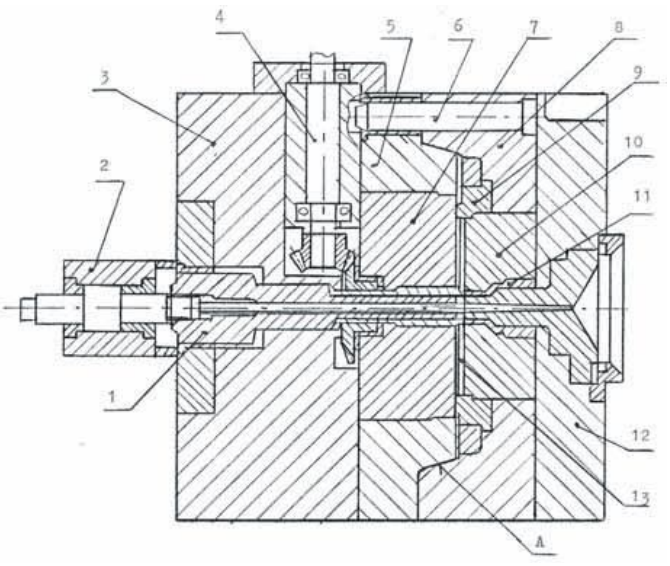

Fig. 1

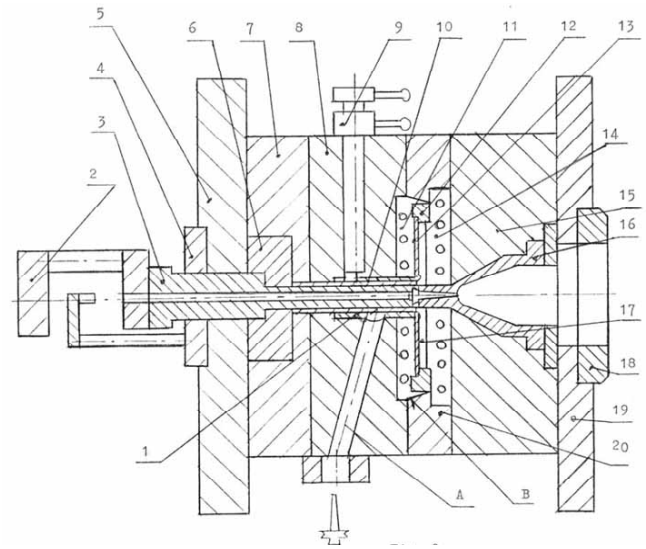

Fig. 2

substrate periphery forms a spacer ring 12 attached to the block moving half. The stamper holder bush 1 is moved along the mould block axis by an eccentric mechanism 9. The driving of the system forming the central hole of the substrate is done by mechanic system 2, fixed to the mould moving half.

Having in mind the constructions of the mould block considered, a conclusion can be made that it is possible to look for some perfection of the system which centers the mould fixed and moving block as well as of the other elements included in it. On the other hand the searching for an appropriate combination of the positive features of each design with the purpose to obtain the best structure of the mould block for optical disks substrates, is possible. The application of different, better solutions in the design of the elements forming the mould cavity, is also possible.

The present paper proposes a design of the mould block for optical disks substrates, which includes all the necessary subsystems and elements, forming the mould block cavity. Systems for moving bushes of punch and sprue type along the mould block axis, are attached to the block. The purpose of the study is on the basis of the known mould block constructions for polymer substrates to design a mould block combining their positive sides on one hand and on the other - to offer new, more reliable and simplified construction solutions of some significant systems and block elements.

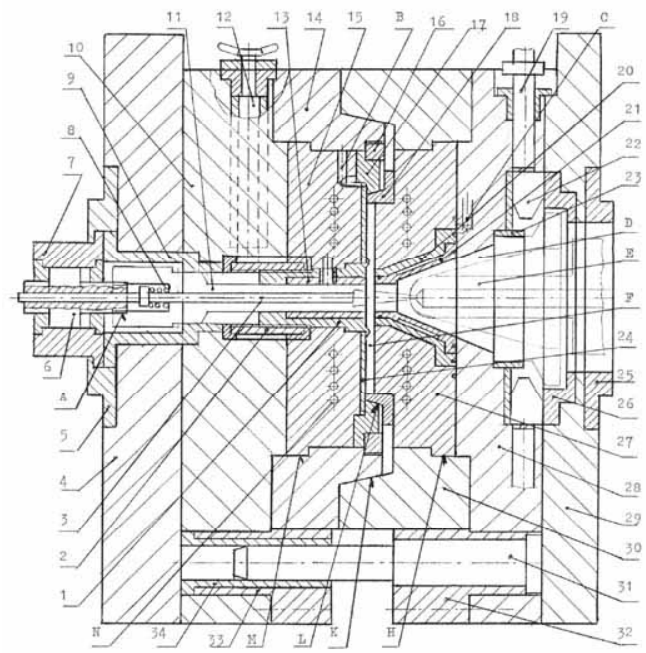

Fig. 3

Fig. 3 shows a longitudinal section of the suggested construction of the mould block for optical disks substrates. The

mould block comprises two basic elements: a fixed and a moving half, forming in-between the cavity "F" of the mould block. The moving half of the block contains the immobily attached one to another rear plate 4, mould plate 10 and circular mounting plate 14, which has in its front end a conal surface "K". In the mounting plate 14 a mirror insert 15 is placed and towards its front surface stamper 24 is attached. The attachment of stamper 24 to mirror insert 15 is realized by a worm mechanism, consisting of a worm screw 12 and worm bush 2. Stamper 24 is fixed round its outer diameter with the help of a spring-mounted ring 17. A hydraulic cylinder, enabling the movement along the axis of the mould block of a bush that forms the substrate central hole, is attached to rear plate 4. The centering of the separate plates one to another, executed along the cylindrical surfaces "M" of plates 10, 14 and 15, is a characteristic feature of the mould block moving half. Bush 9 centers the rear plate 4 to the mould plate 10. Bush 9 functions as a guiding element also when locating a system, which forms the substrate central hole. The fixed half of the mould block includes the immobily attached one to another front plate 29, mould plate 28 and mounting plate 30. A mirror insert 27, which shapes one side of the substrate with its front surface, is put in mounting plate 30. Plate 30 has at its front edge conal surface "K", contacting with the conal surface of plate 14 of the mould block moving half. A spacer ring 18 is attached to mirror insert 29, forming the substrate periphery. Ring 18 is with a front conal surface "L", contacting with the conal surface of ring 17 of the mould moving half. There are concentrically located one into another bushes 20 and 21 along the axis of the mirror insert 27. Bush 20 has channels for air feeding under pressure to cavity "F" that separates the ready article from the mould block. The position of bush 21 is a new construction solution. When using a punch bush to form the substrate central hole, bush 21 plays the role of a sharp edge cutting the sprue, and the channels for cooling contribute to better toughening in the region around the substrate central hole. On the other hand bush 21 provides the necessary space, which allows the use of other sprue systems after replacement. Two hydraulic cylinders are additionally attached to the mould fixed half that with the help of elements 19 drive the beveled strips 22, thus allowing the sprue bush movement along the mould block axis. A system of 4 guides 31 and guide bushes 34 is attached to the mould block for an apriori centering of the moving and fixed half one to another.

More precise centering is done by conal surfaces "K" of the mounting plates 14 and 30 and by conal surfaces "L" of rings 17 and 18 as well. The mould block is characterized by the specific shape in the geometry of some elements, which allows variability in the design solutions of some important systems and elements. Fig. 4 shows two variants of formation of the periphery substrate by different design of rings 17 and 18. In this case the substrate thickness is formed in the mould moving half unlike the design solution in Fig. 3.

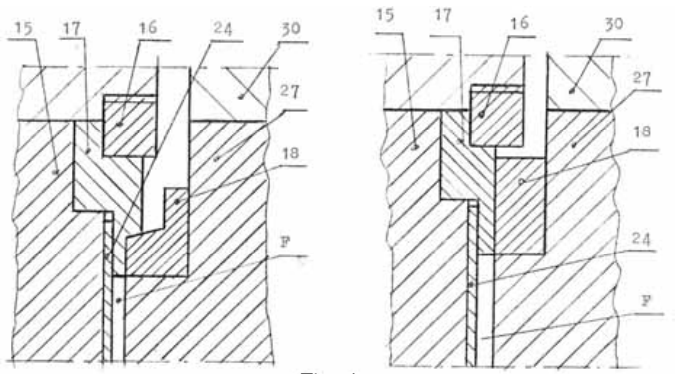

Fig. 4

The design of the mould block for optical disks substrates is an expansion of the known up to now constructions of mould blocks. Some improvements in the centering of the moving and fixed halves of the mould block are sug-

gested at that and centering of the mirror inserts with respect to the block plates and the rings, forming the substrate periphery. This increases the reliability in obtaining a product with concentricity of the central hole with regard to the outer diameter and parallelity of the surfaces in conformance with the existing standard. A system of hydraulic cylinders driving the sprue bush or other bushes is additionally mounted to the block fixed half. This enlarges the possibilities for adding other constructive solutions of the sprue system to the mould block. The including of a hydraulic cylinder to the mould moving half, driving the system that forms the substrate central hole and the including of a system of hydraulic cylinders to the fixed half driving the sprue bush allows independence of the mould operation on the type of the machine used for injection moulding. The appropriately shaped space along the axis of the mould block, as well as the bushes and the other elements located in it, enable multivariancy in the design concerning the system, which forms the substrate central hole, the sprue system and the system of rings, forming the substrate periphery.

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Една конструкция на основния блок на шприцформа за полимерни подложки на оптични дискове

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(Резюме)

Предложена е конструкция на основния блок на шприцформа за полимерни подложки на оптични дискове, включваща пакет от плочи, елементи и подсистеми, образуващи подвижната и неподвижната част на шприцформата, с възможност за многовариантност на конструктивните решения на системата за оформяне на централния отвор на полимерната подложка и леяковата система, както и на системата от елементи, оформящи периферията на подложката. Към блока на шприцформата е прикрепена система от хидравлични цилиндри, осигуряваща възможност за придвижване на системата за оформяне на централния отвор на подложката и леяковата система по оста

на шприцформата, което осигурява възможност за монтиране на шприцформата върху всяка една машина за леене под налягане на подложки за оптични дискове. В конструкцията на блока на шприцформата е приложена комбинирана система за центроване на подвижната и неподвижната част една спрямо друга, както и конструктивно решение за центроване на плочите и елементите един спрямо друг. Прецизното центроване между подвижната и неподвижната част и отделните елементи на шприцформата един спрямо друг създават предпоставка за формоването на подложка със завишени критерии по отношение на концентричността между централния отвор и външния диаметър и успоредността на повърхнините.