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TOOLS FOR CUTTING GEOMETRIC BODIES FROM PENOPLAST

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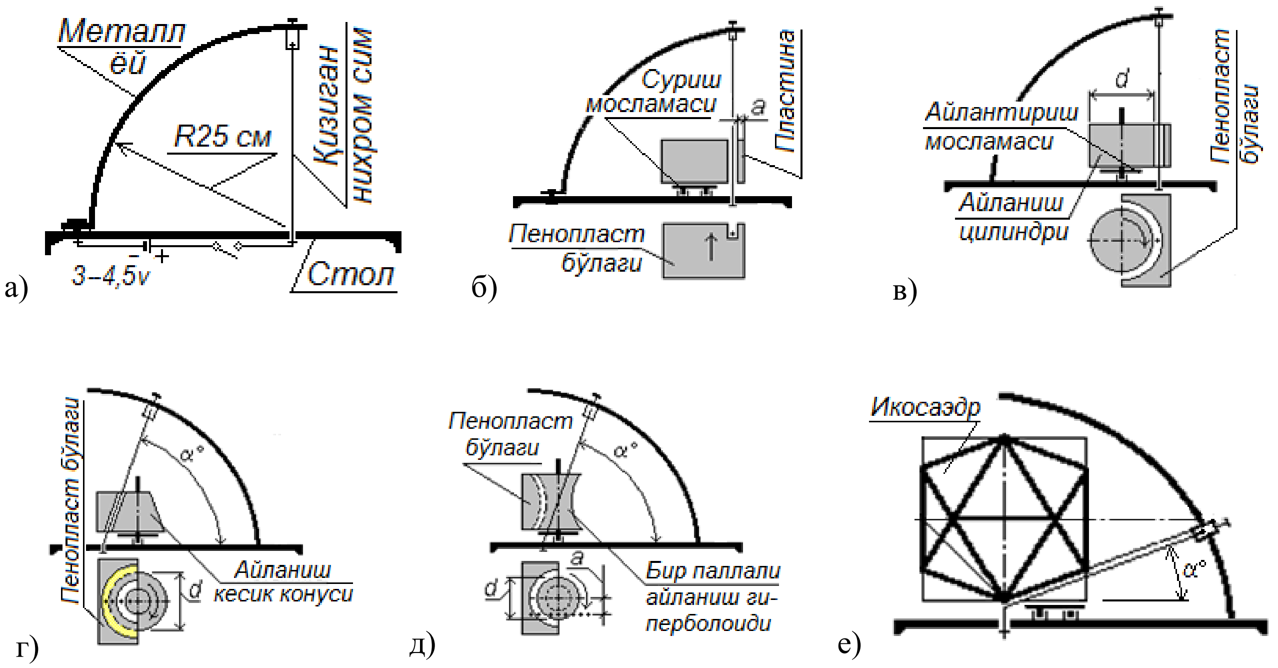
A B S T R A C T	K E Y W O R D S
The article provides scientific and technical information about the devices manufactured in the student scientific and technical circle of one of the universities and their application to cutting out various interesting geometric bodies from foam.	foam, cutting device, cylinder of rotation, truncated cone of rotation, single-cavity hyperboloid, dodecahedron, icosahedron, closed prismatic helical surfaces.

INTRODUCTION

During one of the stages of collecting scientific and evidence material for our master's theses, we had to get acquainted with the activities of the "Technical creativity and design" scientific and technical circle, which operates under the "Engineering and computer graphics" department of the Namangan Institute of Engineering and Construction. The activity of the club is directed to the preparation of posters and three-dimensional illustrative materials (layouts, models) for scientific and research works on engineering geometry and design, as well as educational activities in these subjects.

The circle has been making its products from more traditional materials such as cardboard, plastic, pieces of wire. Recently, they have mastered the technology of creating various geometric objects by creating special devices and using them to cut foam plastic. Below we want to describe our impressions about these tools.

The first of the tools designed to make various geometric objects by cutting foam plastic is a simple table with a square surface measuring 35 x 35 (cm), and an arc-shaped detail made of metal is attached vertically to one end of it. A 3.5-4 volt battery is installed on the bottom of the table. A wire from an arc-shaped detail is connected to one pole of the battery. A clamp is attached to the arcuate part, which can move up and down at different angles along the body of the arcuate part. Also, if the required voltage is applied to the clamp, a nichrome wire is placed along it, which heats up to the level of reddening. The other end of the nichrome wire is tensioned and connected to the second pole of the battery under the table through a disconnector (vykyuchatel). When voltage is applied to this nichrome wire, it is heated and the device enters the working state (Fig. 1, a).



1-fig.

If the tool is additionally equipped with push (slider) or rotary devices, its ability to cut various geometric objects from a piece of foam plastic increases. Figure 1b shows the same |a| from a piece of polystyrene using this tool The process of shearing thick plates is shown. Figures 1-v and 1-g show the processes of cutting out geometric objects such as a cylinder of rotation and a cone of rotation section from a piece of styrofoam using the same tool.

If the positions of the nichrome wire intersecting with the geometric axis of the body of rotation are given the position of straight lines that do not meet, and in this case, the piece of foam plastic is rotated around the axis of the additional device, as a result of such movement, a single-circuit hyperboloid is formed (Fig. 1, d).

In order to achieve results similar to those shown, it is necessary to know the name of the geometric body produced by cutting and its dimensions representing the corresponding distances and angles. For this purpose, it is advisable to prepare a special project based on the horizontal and frontal projection drawing of the geometric body, which is initially cut out of a piece of foam plastic.

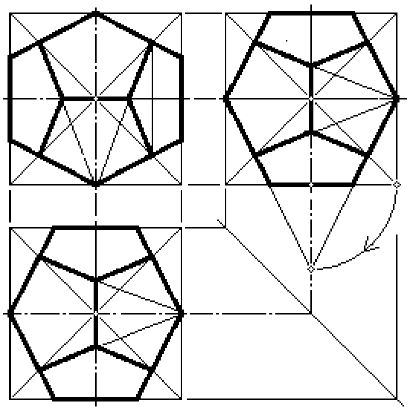


Figure 2. Dodecahedron.

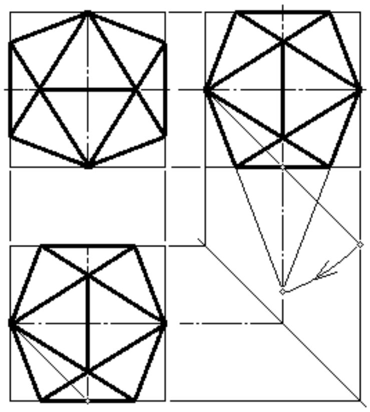
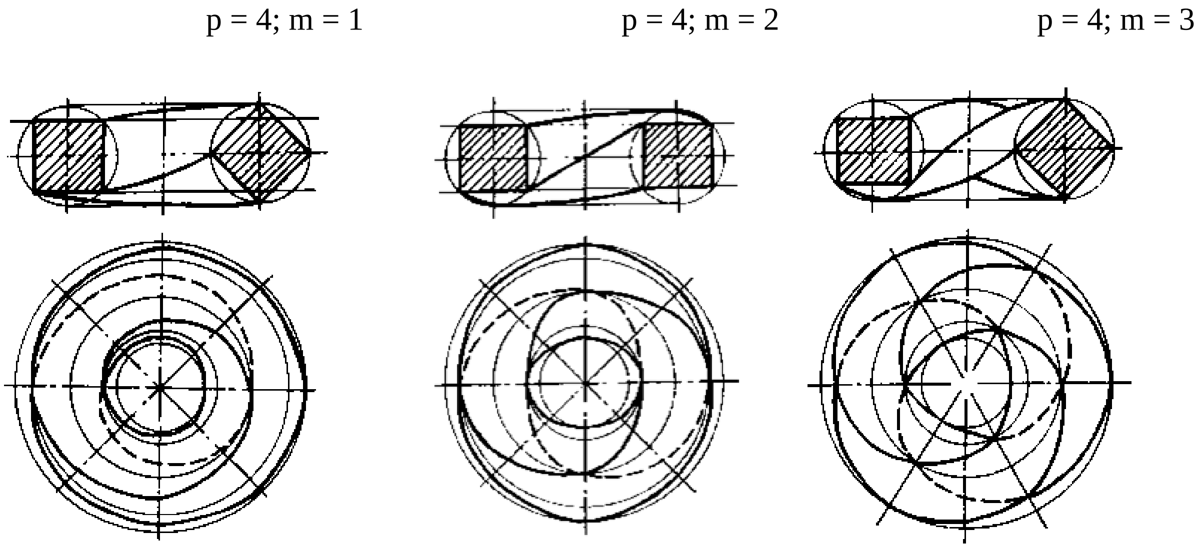


Figure 3. Icosahedron.

Let's say that the problem of making regular polyhedra (tetrahedron, hexahedron, octahedron, dodecahedron and icosahedron) from a piece of foam plastic was raised using the tool in question. In order to solve the problem, it is necessary to develop a good scientific idea or a scientific hypothesis, taking into account the features and capabilities of the device. Let's say one such idea has the following content: **any regular polyhedron (Platonic polyhedron) can be cut out from a piece of cube-shaped styrofoam very precisely and easily.** The basis of such an idea can be served by the cases of representation of the octahedron and dodecahedron placed inside the cube in the complex drawings in Figures 2 and 3. With the help of drawings similar to these, it is possible to determine the angle between the lower base of the **tanovar** (zagatov-ka) cube and the corresponding side of the octahedron or hexahedron and establish the same situation for the sharp nichrome. For information, we can say: when forming octahedron and icosahedron from a cube-shaped piece of styrofoam in the way shown in Fig. 1-e, it is necessary to install the pan in the necessary positions and pass the "knife" 12 times.

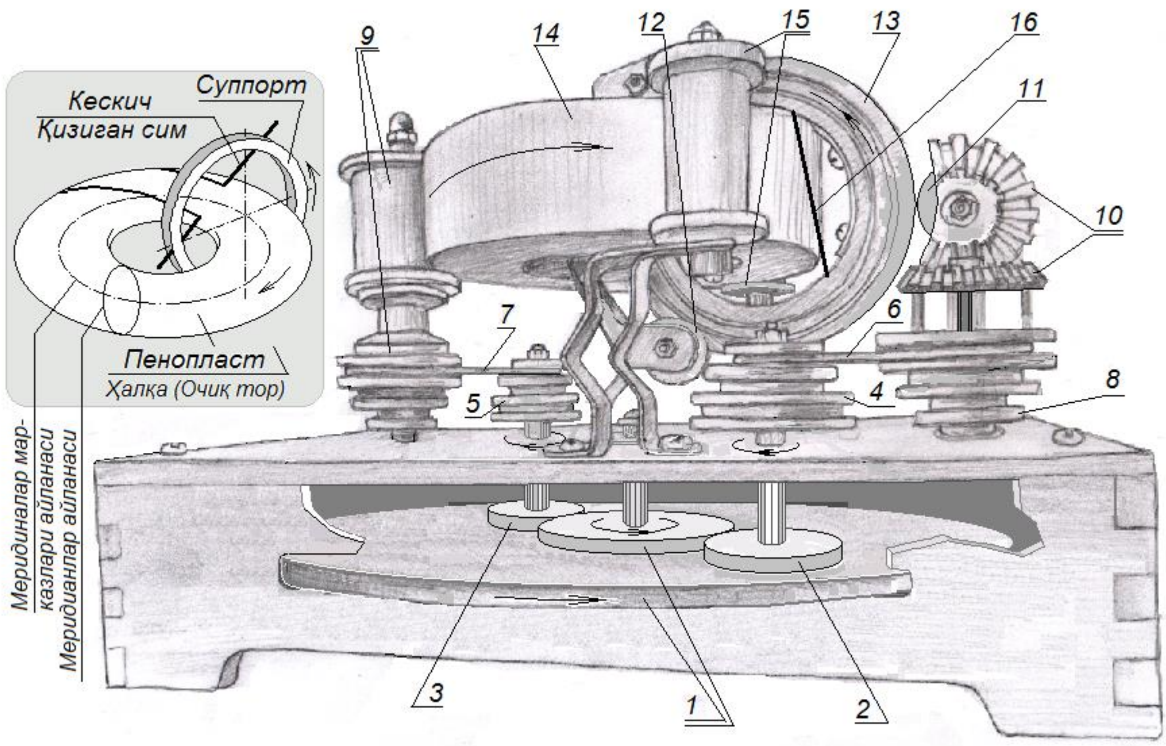
The second of the tools developed by the members of the "Technical Creativity and Design" scientific circle of students to make various geometric objects by cutting out pieces of foam plastic is related to geometric objects known as doubly curved cylindroids or closed prismatic screw surfaces. To begin with how this tool works, it's best to give a brief introduction to the closed prismatic screw surfaces themselves..



4-figure.

Figure 4 shows, as an example, drawings of closed prismatic surfaces with symbols {p = 4, m = 1}, {p = 4, m = 2} and {p = 4, m = 3}. Closed prismatic screw surfaces (YoPVS) are formed on the basis of a grid consisting of how many parallels (p) and how many meridians (p) on the surface of an open ring, and **the circle of the centers of the meridians in the outer ring** and **the diameters of the circle of meridians** (Fig. 5, fragment on the left) differs [1]. The shape of the EOPVS is determined on the basis of the formula k = p/m. Any number can be used instead of p and m here. The limit is determined by the party giving the issue.

The formula of YoPVS k = p/m is used as a basis for the design of the tool that cuts out the geometric objects of the shape created in this way from foam plastic. In particular, it is recommended to give the shape of an open bowl of the necessary dimensions to the YoVPS tanovary (zagotovka) to be made (Fig. 5). One of the important executive parts of the tool is the annular support, which ensures that the heated nichrome wire is given the right position at the right time (Fig. 5, fragment on the left). That is, the pan made of foam plastic rotates around its axis, at a certain speed and in a certain direction. Such a movement - that is, rotation around its axis, at a certain speed and in a certain direction - is also carried out by the support. The cutter of the support (heated nichrome wire) gives the desired shape to the pan and cuts off the excess parts..



5-figure.

In order to organize such precise movements with a high level of compatibility between the drum and the support, it is necessary to attach some additional devices to the instrument. According to Figure 5, these are: 1 – belt (turned in the indicated direction by pinching with fingers); 2 and 3 – wheels (they rotate under the influence of a smaller wheel 1 fixed axially to the belt 1 and turn their respective vertical shafts); 4 and 5 – blocks of pulleys (they are attached to the axles coming out of wheels 2 and 3, and when the axles rotate, they rotate together with them); 6 and 7 - belts (they transfer the rotational movement of the blocks of pulleys to the blocks of pulleys in positions 8 and 9); 9 – roller (it rotates together with the block of pulleys 9 and rotates the foam pan 14); 15 – rollers (they are 2 pieces and ensure rotation of the pan in a steady state); 10 – bevel gear wheels (they are 2 pieces and change the vertical axis rotational movement in the block of pulleys 8 to the horizontal axis rotational movement); 11 – roller (it rotates together with a bevel gear wheel with a horizontal axis and transfers its rotational movement to the flange-shaped support 13); 12 - rollers (they are 3 pieces including roller 11 and ensure rotation of the support in a steady state); 16 – nichrome wire heated by electric current (it rotates with the support and cuts the pan 14 rotating around its axis according to the image in the project).

а) б) в) г)

Figure 6. Cut from a narrow (ring) shaped penoplast pan made YoPVS: а) *k* = 2/3; б) *k* = 3/3; в) *k* = 4/3; г) *k* = 2/4.

All such transmissions serve one result: the foam board 14 rotates around its axis at a given speed r, the support 13 rotates around its axis at a given direction along with a heating wire connected to it in the form of a coil at a given speed m. As a result, the penoplast takes the form of YoPVS, defined in the form of ta-novar k = p/m. The sizes of the driving wheels in the device are selected so that, even if we do not carry out the transmissions in any combination, the numbers p and m will be integers. The wheel-to-wheel transmission speed ratios are changed by shifting belts 6 and 7 to pulleys different from those shown in the figure. In this case, it is planned to install 6 or 7 belts in the form (and, if necessary, to reverse the movement. Depending on the parameters of the YoPVS being created, how far the heated nichrome wire 16 should be from the center of the support is also not neglected.

Fig. 6 shows samples of the PVCs made by cutting narrow (ring) foam plastic sheets with the help of a tool made by the members of the "Technical creativity and design" scientific and technical circle: a) k = 2/3; b) k = 3/3; c) k = 4/3; g) k = 2/4.

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