



AUTOMATION OF MACHINES FOR PROCESSING OF AMBER BALLS AS JEWELRY

Yuriy Kuznietsov*

National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic institute"

ARTICLE INFO

Article history:

Received 21 September 2021

Accepted 15 October 2021

Keywords:

amber beads, grinding, productive of production, modal principle

ABSTRACT

The purpose of the work is creation of productive automatic machines for grinding amber beads with minimal costs for its manufacture and exploitation, providing high quality through parallel processing of the rocker, modal principle, the active control and computer control.

© 2021 Journal of the Technical University of Gabrovo. All rights reserved.

1. INTRODUCTION

Relevance of the problem:

1) Rational use of nature in the exploitation of natural minerals of amber (removal of mineral soil on the surface of the field leads to changes in soil structure, the formation of cavities and has a significant negative impact on the environment).

2) Removal of a person from the field of manual labor with dust and hazardous waste based on full automation of digital technologies.

3) High productivity of automated equipment (at least an order of magnitude higher than manual labor).

4) The quality and attractiveness of finished products (jewelry), an extremely wide market for the consumption of amber balls for beads, bracelets and pendants.

5) Use in engineering (a good electrical insulator, a competitor to fluoroplastic 4), chemistry (amber varnish) and medicine (medicine for various diseases).

2. HISTORICAL INFORMATION

In the ancient language, the word "amber" (in the form of "entar") came in the early XVI century (mentioned in the chronicle of 1562) [18-20]. "Old Russian, therefore, the Slavic designation - Gentator, hence the Lithuanian Gintaras and Russian - amber." It is also believed that the Russian word is borrowed from Lithuanian, because Lithuanian tribes usually lived on the amber shores, and Russians are very rare.

The main areas of application of amber: jewelry, art, technology.

Amber jewelry is a characteristic detail of women's clothing on the territory of the Forest-Steppe Right Bank, as evidenced by women's burials of early Scythian times. The brightest complexes were recorded in mounds near the villages of Synyavka, Bobrytsia, Kazarovka, Medvyn, Matusiv, Jabotyn, HuliaiHorod, Basivka (Cherkasy region).

Secondary placer coastal-marine deposits are of industrial importance.

Amber succinite - a fossil resin from the pine "pinussuccinifer" - covers several areas on the location map. In geological terms, the most widespread is the Baltic succinite. The same composition of the gem was found in Ukraine (near Kiev, Kharkiv, Volyn). In Ukraine, Paleogene and Neogene sediments are found in Rivne (Sarny, Volodymyrets and Dubrovysia districts), Kyiv (Kyiv amber - a product of accidental leaching of fossil resin, ie, this source was not permanent), Zhytomyr, Lviv and Kharkiv regions. The large Klesivske deposit (in Polissya) began to be developed relatively recently, because succinite is quite deep here.

The world's largest industrial amber deposit is located forty kilometers from Kaliningrad, near the village of Amber, where organized industrial production and processing. The pit of the amber quarry is located near the shores of the cold Baltic Sea. The quarry resembles a giant bowl. People are almost invisible here: all the work is done by cars.

Amber-bearing "blue earth", really shining blue, especially in the sun, lies under a thick layer of hollow rock. Amber is contained in a layer 5-7 meters thick. To get to it, you must first cut a thirty-meter pillow. Beneath it rests the amber rock. How do you get to it? Overburden works are successfully performed by water. A powerful, resilient jet of hydromonitor hits the earthen wall. The capacity of the dredger is about 200 cubic meters per hour. The silver jet, which flies under the pressure of eight atmospheres, not only destroys the rock, but immediately on the spot turns it into pulp, which the suction pump drives into the sea. This technology of stripping works here, near the sea, is the most economical.

Amber is found in Sicily (there it is called simethite), in Romania (blush), Myanmar (Birmite), Canada, in some parts of the Atlantic coast of the United States, Mexico, the

* Corresponding author. E-mail: info@zmok.kiev.ua

Dominican Republic (Dominican amber) [19]. In Ukraine, there are three explored deposits in Rivne region, Zhytomyr region and one - in Volyn region [18]. A small number of amber deposits are located on the coast of the Baltic countries.

3. CURRENT STATE OF MANUFACTURE OF AMBER BALLS

In different periods of time in countries with deposits of amber and other precious minerals and stones, to obtain jewelry from raw materials for individual, small-scale, serial and mass production, the technological process was divided into separate stages (stages, operations), starting from the inspection of raw materials, its preparation for processing, roughing and finishing, providing the appearance of the finished product and its evaluation [7, 12, 15].

When processing natural amber, it is necessary to undergo a number of special preparatory operations to process amber. First, the amber is cleaned and sorted, as the appearance of natural stone is relatively inconspicuous, amber is covered with a brown oxidized crust. After careful sorting, the gem is delivered to a mass production shop, where the surface crust is removed from the stone, polished and it is seen what the new material is. Preparations of future products are roughly processed pieces of natural amber. On the abrasive machine the sun stone is given the necessary form. This procedure is called rough grinding.

Among the main types of amber processing can be distinguished: peeling, forming, leveling, grinding, polishing and the so-called mirror effect and pressing.

Peeling - removal of crust, patina, formed as a result of weathering, with coarse-grained skin, file. Peeling is always started from the transparent side of the stone, which was once returned to the sun. The lower cork part will be a great background for the future amber product.

Forming - giving the workpiece the intended shape. With the help of the same tools and devices, the stone is given a certain volume, silhouette, spatial pattern.

Alignment - the product obtained after peeling and molding has a relatively rough, with visible scratches, rough appearance. The whole surface is smoothed with a medium-grained skin. The movements of the skin or stone - light, without pressure, circular, rotating.

Grinding - this technique exactly copies the previous one, only in this case the skin is taken of finer grain. This technique should be carried out in several measures, gradually, reducing the degree of granularity. The skin is waterproof, the treatment is carried out by moistening the stone or skin.

Polishing is the final operation that gives an amber product a perfect "commercial" look. Performed by hand on felt, leather, felt, flannel or braid, rotating wheels made of the same material. In the production of amber products are polished on a lilac circle, rubbed with a special paste of amber chips, paraffin and chalk. Light circular motions are polished by hand. On rotating wheels, the surfaces are polished with a light touch and constant movement.

Mirror effect. At high-quality polishing, in a glossy surface of amber, as in a mirror, all subjects are reflected. After finishing, the gem is placed in a specially designated place for him, and then strung on a thread, inserted into the frame, fastened with a chain or glued to the base, etc.

Another method of amber processing is pressing. Amber is very malleable when heated. The amber ingot is cleaned of the original crust. The crust of resin is removed with a drum in which the stones rotate, at the bottom of this machine is a grinding wheel, on which the amber rubs. Then the amber is ground into a powder and laid in molds. At a temperature of 180-220 degrees and pressure, the powder becomes a viscous mass. Then it is formed and allowed to solidify by cooling. Such amber is used in the jewelry industry, for the manufacture of medical utensils and is used in industry as an insulator. There is also a chemical treatment of amber. Residues after processing of large stones are heated in tanks at a temperature of 350-370 degrees, and as a result of chemical reactions amber decomposes into amber oil (15% of the total mass), succinic acid (1.2%).

The study of literature sources and analysis of information on the Internet showed [1-4, 20, 22-24] that for making jewelry of various shapes from amber in terms of individual, mostly manual, production process consists of five consecutive stages (fig. 1,a), and for industrial production of at least seven consecutive stages (fig. 1,b).

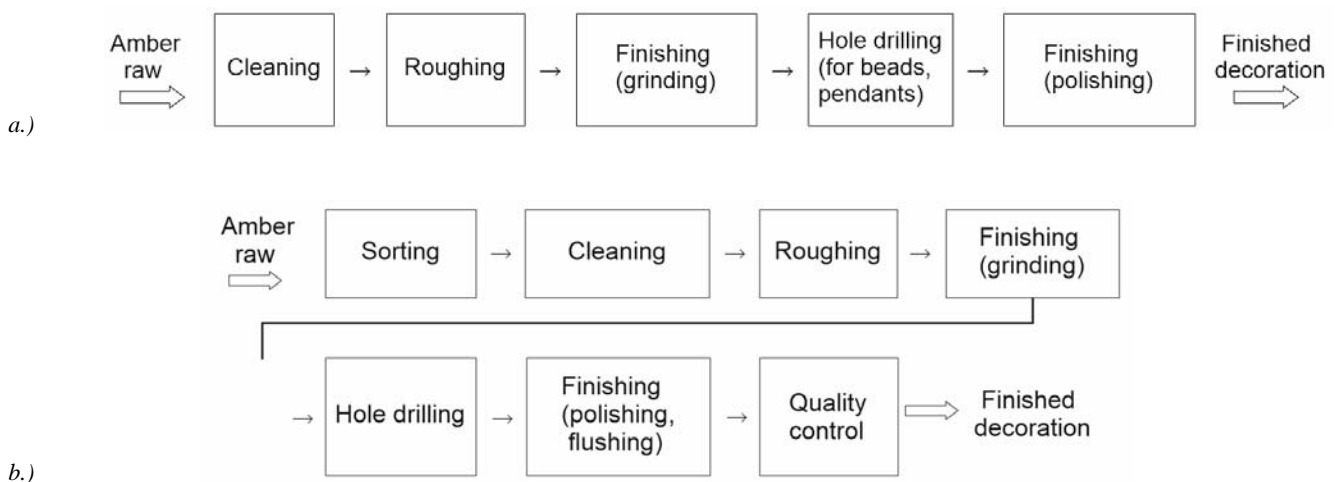


Fig. 1. Technological process of individual (a) and industrial (b) production of amber balls for jewelry

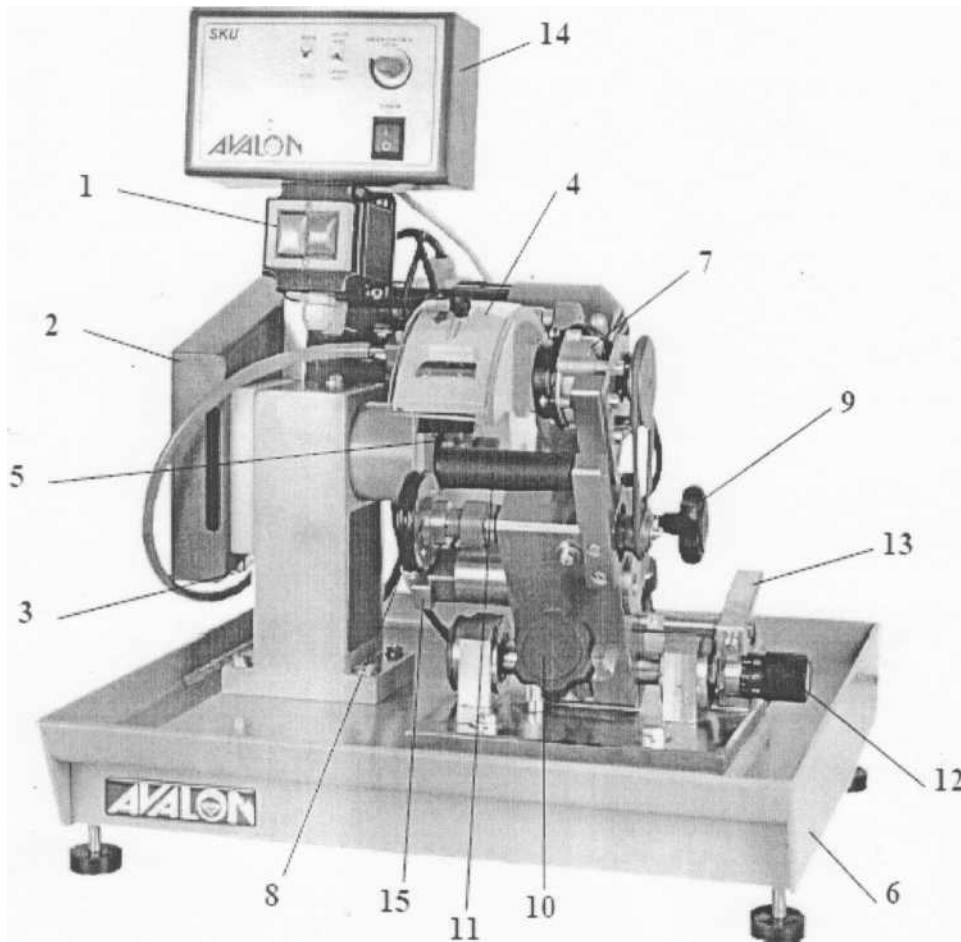


Fig. 2. SKU machine of the Polish firm "Avalon" [20]: 1 - the control panel; 2 - protective cover of a wedge belt; 3 - the crane for water connection; 4 - protective cover for the profile circle; 5 - grinding wheel; 6 - machine bed; 7 - motor (12V) auxiliary; 8 - roller guide; 9 - the handle of adjustment of the size of balls; 10 - blocking the movement of the pendulum mechanism; 11 - the handle of the pendulum mechanism; 12 - adjusting screw for moving the pendulum mechanism; 13 - limit switch; 14 - control panel; 15 - support under the ball

The current state of the technological process of making amber balls for jewelry indicates a lack of mechanization and automation, especially in the early stages and rough grinding. Nowadays, roughing of balls is performed in a mechanized way on grinding machines. An example of such a machine can be a grinding machine SW1 company Avalon (Poland) (fig. 2) [22, 23], which is designed for manual grinding of jewelry, stampings, castings, production stones, amber and other products, with the supply of coolant (water). It is possible to install a grinding wheel with a diamond coating or with a special waterproof skin. Obtaining a fairly accurate spherical shape of amber "calibrated" balls is carried out by grinding the semi-finished product in the form of a "crumpled" ball on specialized grinding machines.

When drilling holes in amber products were obtained mainly machines with manual control. A typical representative of such machines is a drilling machine WK1 of the Polish company "Avalon" [15].

A representative of the automated equipment for drilling of amber products is a machine designed and manufactured by GTV, Kaunas (Lithuania) [21]. The machine has a modular structure. In the spindle block four spindles, giving of products is carried out by means of pneumatic transport in the general giving plate with nests. The plate is moved from left to right, sequentially installed under the spindle, drilling is performed, after which the plate is moved to the right further to the unloading position. It then quickly returns to the loading position in the far left position.

To give the products an even more attractive appearance, they are processed on grinding and polishing machines. For grinding use fine-grained sandpaper and wheels. For the final polishing use polishing wheels made of cotton fabric, which are applied polishing paste. An example of machines used in polishing amber products are shredding machines from Avalon (Poland) [21, 23]. Vibrating machines of the named firm are also used. An example is the vibrating installation WE6 (fig. 3). Details by the vibrating method (metal products, jewelry stones, ceramics, glass, etc.) in small volumes.

The most common, widely replicated amber "detail", which is part of many jewelry (necklaces, necklaces, pendants, brooches, etc.), is kulmrf ("bead") with a diameter of 3 to 20 mm (sometimes more, but rarely) [3]. There are amber balls of relatively irregular shape ("mint") and balls with high accuracy of the spherical surface (high precision). The term "high precision" in relation to the amber ball is conditional (it is still not a ball bearing). But if, for example, for a "crumpled" bullet with a diameter of 5 mm, the tolerance for the diameter is 1-1.2 mm, then for "high-precision" of the same diameter - only 0.05 ... 0.1 mm. Given the above, for quality control processing of amber balls uses conventional measuring tools, such as calipers.

To ensure the maximum utilization rate of amber raw materials, it is necessary to provide two technological processes (fig. 4).

Analysis of technological processes existing today in world practice shows the lack of a closed automated complex for processing amber raw materials into jewelry and, in particular, for the manufacture of beads.

Due to its multifaceted properties, amber is increasingly attracting attention in terms of its extraction, processing and use, which determines the urgency of solving the problem of improving productivity and quality of processing while reducing raw materials.

Improving productivity and processing quality to obtain the finished product is possible through the replacement of manual labor, the use of new technologies and automated equipment [1-4, 23, 24]. The transition from manual and partially mechanized production of amber products to automated should be performed by the gradual elimination of bottlenecks in the technological chain of the workpiece (amber-raw material) - the finished product (decoration).



Fig. 3. Vibrating WE6 installation of Avalon firm (Poland)

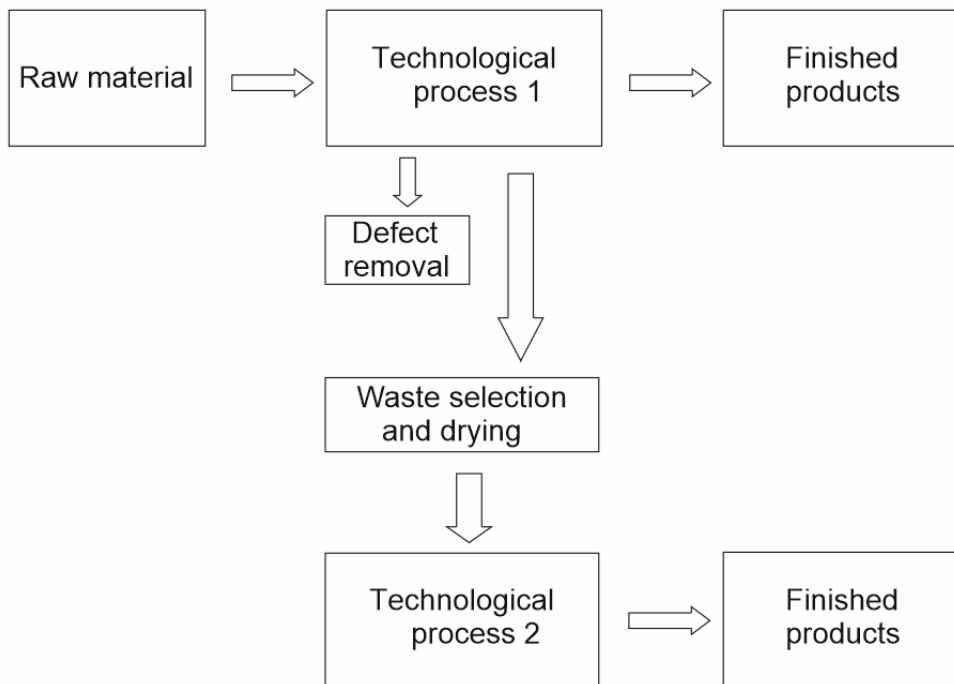


Fig. 4. Variants of technological processes of making balls

At the Department of Machine Design KPI Igor Sikorsky [6] developed and researched the creation of high-performance automatic machines for grinding amber balls after automatic sorting with minimal costs for the manufacture of the machine and its operation and ensuring high quality through parallel multi-position processing, modular principle, active control and computer management.

The conceptual layout of the machine consists of 3 sections, each of which includes 2 processing modules (fig. 5) [10].

Bulvis designed and manufactured using the modular principle of the existing layout-prefix with automatic feeding on a computer program.

When conducting an experiment on the machine mod. SKU company Avalon (fig. 2), equipped with a layout-prefix automatic feed (fig. 6) empirically found that the

average processing time of one ball per cycle is 110 seconds. It should be borne in mind that this prefix was made in the form of a layout, which prevented an increase in the feed rate and consequently increased the duration of the processing cycle.

In the case of using high-quality and customized equipment, the cycle time can be reduced by 3-5 times or more by increasing the sections (working positions), which are serviced by one person. Thus, if 1 processing cycle averages 60 seconds, then using 6 processing modules you can get 360 balls per hour and 2880 balls per shift (8 hours). The advantages of the designed machine include such characteristics as: simplicity of construction; modular principle of machine construction; high productivity, low cost; wide opportunities in terms of modernization and search for new principles of processing [9, 11, 12].

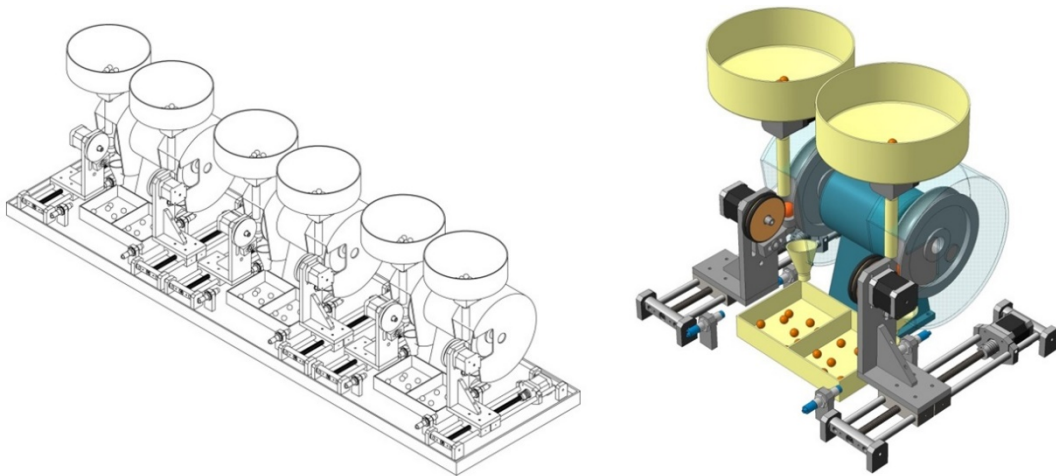


Fig. 5. Layout of the multiposition automatic machine of parallel action: a – the general type of the machine consisting of 3 sections; b – General view of one section of the machine



Fig. 6. The machine of the SKU model of Avalon firm (Poland), equipped with the model prefix of automatic radial giving of balls

4. CONCLUSIONS

The performed feasibility studies indicate that instead of selling raw amber, it is advisable to invest in the creation of domestic high-performance multi-position machines with

CNC for the manufacture of balls for jewelry, which are in great demand in the world due to their useful properties. As a result, you can get a profit two orders of magnitude greater than the sale of raw materials. At the same time, in a

short pay back period (up to one month) additional jobs appear, the environmental situation in the mining are as improves, and the socio-economic situation of people significantly improves. The end result is assistance in solving the humanitarian, resource, geographical and environmental problems of Ukraine's national security.

REFERENCES

- [1] Borisov B.P., Model of shaping of amber balls on specialized grinding machines / ВР Борисов, Ю. Ф. Pravdin, SS Mikhailov // Izvestiya Kaliningradskogo gosudarstvennogo tekhnicheskogo universiteta 29 (2013) 252-258
- [2] Borisov B.P., Selection and substantiation of the kinematic structure of an automatic machine for grinding high-precision amber balls / В.Р. Борисов, С.В. Цыплаков, Р.О. Yakson // Automation of technological processes: a collection of scientific papers / KSTU. – Kaliningrad (2006) 64-70
- [3] Borisov B.P., Kinematic structure of specialized machines for grinding amber balls and the method of calculating their productivity / ВР Борисов, Ю.Ф. Pravdin // Izvestiya KGTU. –Kaliningrad 11 (2007) 192-197
- [4] Borisov B.P., The machine for processing of balls from amber / ВР Борисов, Ю.Ф. Pravdin, МВ Шульжик, С.В. Tsyplakov // Izvestiya KGTU 5 (2004) 82-86
- [5] Golovastov A., Machine vision and digital image processing / Modern automation technologies, 4 (2010) 8-18
- [6] Kuznetsov Y.M., Improving the productivity of processing amber balls for jewelry/Scientific notes, Lutsk 67 (2019) 70-81
- [7] Nikitin Yu.V., Decorative stones and their processing. Discover the beauty of the stone, Nauka, Len-koetd-e, 1979. - 86 p.
- [8] Novozhilov Yu.N., Tool for making amber beads // "Knowledge-power" 4 (1997) 135-136
- [9] Patent of Ukraine №107052. The method of grinding amber balls, publ.25.05.2016, Bull.№10.
- [10] Patent of Ukraine №111912. The machine for grinding of balls from semiprecious stones, publ.25.11.2016, Bull.№22.
- [11] Patent of Ukraine №129617. Machine for grinding balls of semi-precious stones, publ.11.11.2018, Bull.№21.
- [12] Savkevich SS, Amber. L.: Nedra, 1970. - 192p.
- [13] Srebrodolsky BI, Amber. - M.: Hayka, 1984. - 112 c.
- [14] Tilipalov V.N., Peretyatko S.B., Aleshkevich V.V., Promising technologies and equipment for processing amber / Ed. V.N. Tilipalova - Kaliningrad, KSTU, 2003, 318 p.
- [15] Felkersam A.E., Amber and its application in art (<http://www.eunnet.net/lithica/russ/felk/1912/03.htm>)
- [16] Shapovalov R.G., Amber processing in medieval Novgorod <http://olafiod.oi.ua/s79900/obrabotkayantaryavsrednevekovom>
- [17] Amber - an article from a large Soviet encyclopedia (<http://slovari.yandex.ru/dict/bse/article/00095/02800.html>)
- [18] Amber // Encyclopedic Dictionary of Brockhaus and Efron: In 86 volumes (82 vols. And 4 additions). - SPb., 1890—1907.
- [19] <http://www.jewellery.org.ua/stones/sintetica1.htm>
- [20] <http://www.avalon-machines.pl/>
- [21] <http://www.gtv.lt>.
- [22] http://dkl.ua/Datalogic_Automation/Machine_Datalogic_1.html
- [23] <http://www.mallenom.ru/quality.php>