DEVICE WITH TWO-COORDINATE MOVEMENT SYSTEM FOR IMPACT PERFORATION AND MARKING OF PARTS AND PRODUCTS

OLEH POLISHCHUK[1], ANDRII POLISHCHUK[2], NATALIA PYSHCHENIUK[3]

Faculty of Engineering Mechanics
Department of Machines and Apparatus, Electromechanical and Power Systems
Instytutska street 11, 29016 Khmelnytskyi
[1]opolishchuk71@gmail.com, [2]andrepol215@gmail.com,
[3]natalia.pyshcheniyk@gmail.com

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SUMMARY

Reducing energy costs when performing technological operations of perforating and marking of parts and products by using new types of drives, as well as by selecting the best technological regimes, is an topical task and of interest to many industries.
In order to perform operations of perforation and marking of parts and products, people have developed a device which includes: a system of parts moving, consisting of two mechanisms of movement along the coordinates X and Y; two stepping motors; stepper motor driver (CD); power supply for CD drivers; linear electric motor (LEM) with shock mechanism; LEM power supply and control; electronic calculating machine (ECM).

Mechanical smite with percussion instruments with different types of drives is among the most promising ways to carry out technological operations. It provides a high concentration of load on the local area of the material and its energy of destruction is inferior to only the explosion.

The shock is a collision of two bodies when the interaction takes a very short time. Using the phenomenon of mechanical smite in various industries, we can perform the following operations: parts cutting and holes punching; carrying out the perforations on details; fixing materials clinging to the material; performing the operation of patterns stamping on details; performing the parts/products branding and marking, etc.

The operation of parts punching of the top of different shoes with variable matrices is carried out in order to decorate it and increase air permeability. It is essentially similar to the operation of details cutting. Perforation can be regarded as holes punching of small diameters, the distance between which may be dimensional to the diameter [1].

The analysis of the current equipment state used in light industry enterprises has shown the need and the possibility of further improvement of technological preparatory cutting sectors of light industry production due to the use of high-speed modes of operation. The improvement of productivity and quality of products can be achieved with automation degree increasing of the execution process.

The most commonly used technology for impact marking in the industry is impact-point marking. Impact-point industrial technology (micro percussion marking, needle marking, impact metal engraving, coring, stripping) is the application of individual points (spherical deepening) with the help of a high-strength needle made of solid metal alloys, using ceramics, on different types of materials under orders from the electronic controller.

The marking punch can be actuated with equipment with different types of drives. The pneumatic equipment that supplies compressed air to the labeling equipment modules is most widely used to operate the needles. The impact force can be adjusted, which makes it possible to use the needle marking on the various surfaces of the products. For example, for the aluminum marking, the impact force should be less than when steel marking. In addition, the regulation of the impact force of the needle allows us to make a required deepening on the surface of the product [2].

The effectiveness of punch-point mechanical marking using is expressed in high speed of product processing; absence of consumables; simple usage of the device; simple changing in applied data; high quality at a low cost of labeling equipment.

On the basis of the analysis, it can be concluded that the use of the shock method of parts/products marking and branding in mechanical engineering and light industry and the use of linear tools for working tools (cutters, punches, and needles) are promising in use.

Reducing energy costs when performing technological operations of perforating and marking of parts and products by using new types of drives, as well as by selecting the best technological regimes, is a topical task and of interest to many industries.

When performing these operations, it is especially important to consider the following factors: the speed of processing object movement, the speed mode of the cutting or marking mechanical tool, the thickness of the cutting or immersion in the material with the ability to change the direction of movement of the working tool, the versatility of both the working tool and the entire mechatronic installation in general when working with different materials.

Serial production, which produces up to 80% of total production, is characterized by high costs of working time to perform auxiliary operations. The main way of reducing these costs is the production processes automation through the usage of equipment with computer numerical control (CNC). This equipment achieves a high degree of processing automation and the possibility of its rapid adjustment to the processing of any part or product within the technical specifications. The effectiveness of the CNC machine tools is expressed in increasing the accuracy and uniformity processed workpiece sizes and forms; increasing of processing productivity in several times; reducing the cost of processing.

The work on the development of technical documentation and the production of an experimental installation that performs the operations with the consideration modern methods of controlled destruction of the processing objects structure with given coordinates and the established configuration according to the technological the process is carried out at Department of Machines and Apparatus, Electromechanical and Power Systems (MAEPS) of the Khmelnytskyi National University. The management of an experimental installation is carried out using an electronic calculating machine (ECM). Computer transmits necessary information to move the basic mechanisms within coordinates X and Y, and the stepper motors usage allows to position the working body or processing object with high accuracy within 0,01 - 0,05mm.

Mechatronic installation consists of two main units. A carriage with two-axis movement on the basis of running screws is used as a mechanism for mechanical portal movement with a working tool. The second basic element is the automation complex for stepping motors controlling with computer numerical control. This design allows us to extend the scope of the experimental installation for performing other technological operations, such as laser cutting.

First of all, in order to make up device with two-coordinate movement system for impact perforation and marking of parts and products, it was necessary to develop its structural scheme. The developed structural scheme is shown on the rys.1.

The device includes: a system of parts moving, consisting of two mechanisms of movement along the coordinates X and Y; two stepping motors; stepper motor driver (CD); power supply for CD drivers; linear electric motor (LEM) with shock mechanism; LEM power supply and control; electronic calculating machine (ECM).
Unipolar step motors of the DYNASYN 4SHG-023A 39S brand have been selected for two-coordinate movement system with the following technical characteristics: 1.8-degree turning angle; 200 steps to full shaft turn; 6 leads; 2 windings with an average point; power supply of 2,3V; resistance of winding of 1.5 ohm; current of 1,53 A; the moment of the rotor holding of 4kg·sm.

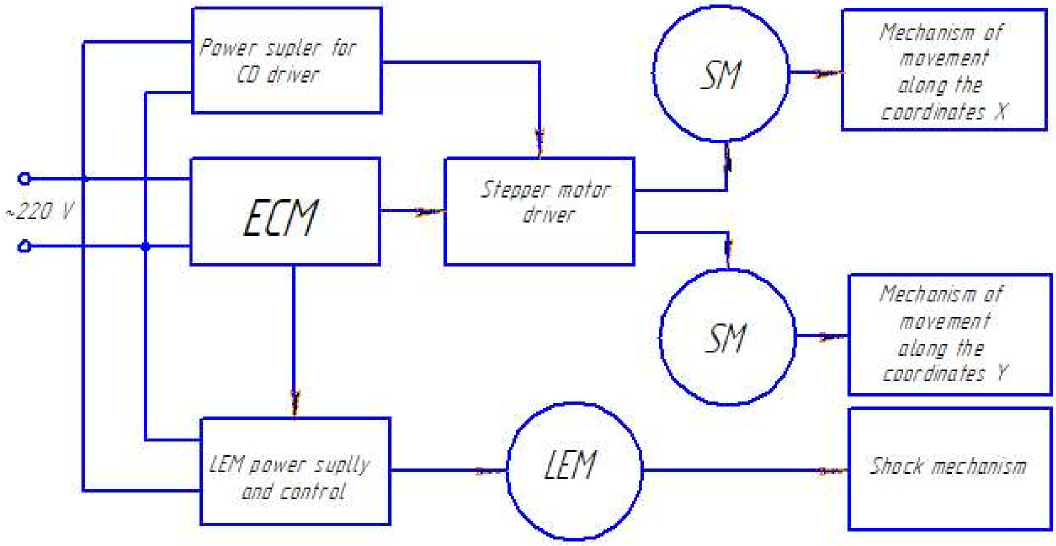


Fig. 1. Structural scheme device with two-coordinate movement system for impact perforation and marking of parts and products

To control stepper motors, an electric circuit is used, described in [3] and shown on the rys. 2.
The power supply from the computer is used to power the drivers of stepper motors. This unit was remodeled in accordance with the characteristics of the power supply, which are powered by stepper motor drivers.
The design of a linear electric motor was manufactured for the punch drive needed for perforation and punching needles for the parts and products marking. LEM is installed on the frame of the machine being developed and fixed.

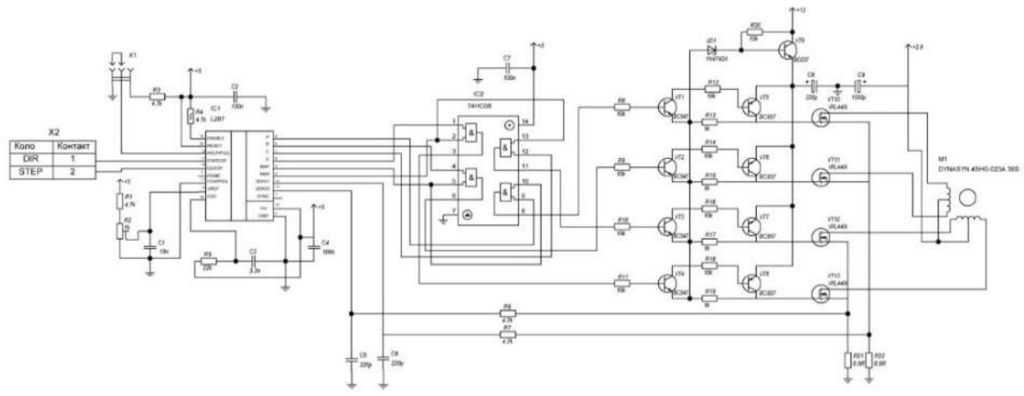


Fig. 2. Electrical diagram of the step motor driver

Linear electric motors represent an independent class of electric machines that have a number of specific characteristics. Unlike rotating electric motors, capable of carrying out a long rotary motion with continuous energy exchange between electric and mechanical systems, the limited mechanical gradual and reverse-gradual movement at the discrete energy transformation is occurred in LEM [4].

To make up a program for controlling the machine with a two-coordinate movement system, the operating system LinuxCNC was used. The control of the device is carried out from the LPT computer port of ECM. Firstly, the setup of step and direction of rotation are made. They are programmed in the Step Config program (rys. 3).

Step Config is a graphical utility for configuring LinuxCNC for various machines. Of course, it does not implement all the capabilities of LinuxCNC, but it fits most step-dri controllers which are controlled through the LPT port. To create a new configuration, you need to click on the "Start" button. Then a new window opens with the option to create a new configuration, replace the old one and import the settings from the Mach3 software (rys. 3, a)

After pressing the "Forward" button, we proceed to the settings and the speed of the installation setup (rys. 3, b)

Description of program parameters (rys. 3, b):

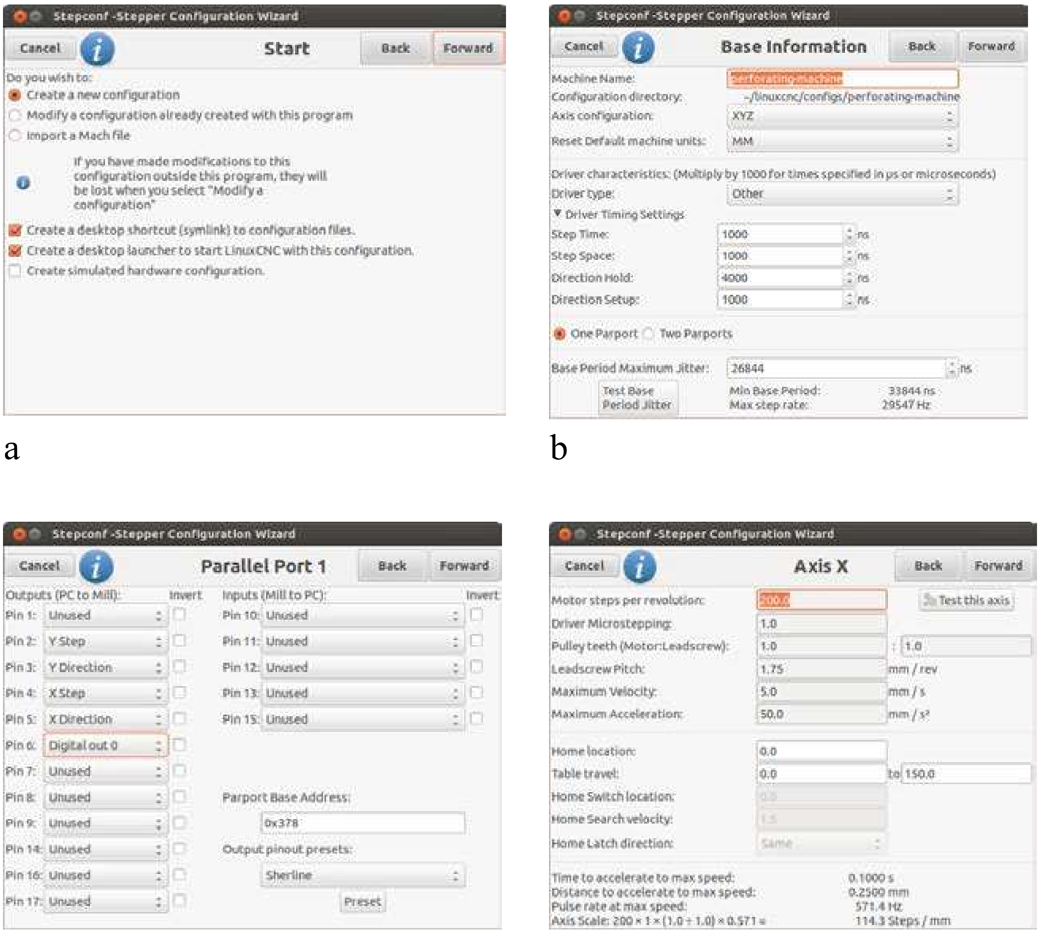
- Machine Name - configuration name;
- Axis configuration – selection of the coordinate's number;
- Reset Deafault machine units - selection of measurement units;
- Driver characteristics - stepper motor driver parameters.

Driver control and power supplies signals are send to the LPT contacts according to the settings in the program (rys. 3, c).

Description of program parameters (rys 3, c):

- X, Y Direction - the direction of the stepper motor rotation;
- X, Y Step - step;
- Digital out 0 – the signal when LEM is on.

To configure the axes, you need to put the data about the driver, stepper motor and screw in the Step Config program (rys. 3, d).
Description of program parameters:
- Motor Steps Per Revolution - number of engine revolutions per one;
- Driver Microstepping - configuration of the controller microstep;
- Pulley Ratio - gear ratio between engine shaft and propeller
- Leadscrew Pitch - screw step;
- Maximum Velocity - maximum movement speed;
- Maximum Acceleration - maximum acceleration for this axis;
- Home Location - home position;
- Table Travel - the boundary of the axis.
The settings for the Y axis are the same.

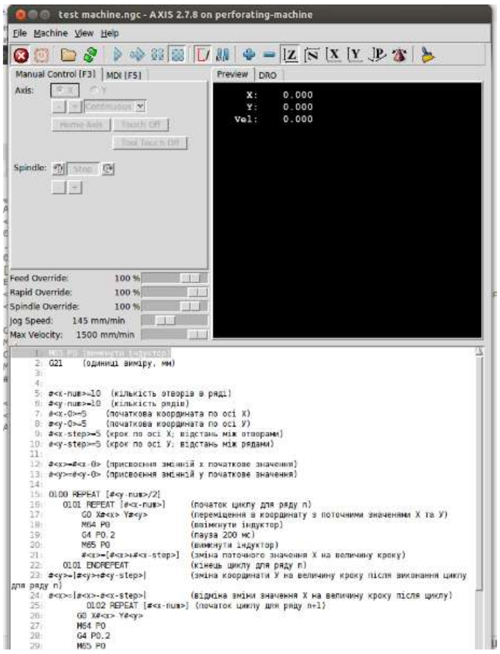


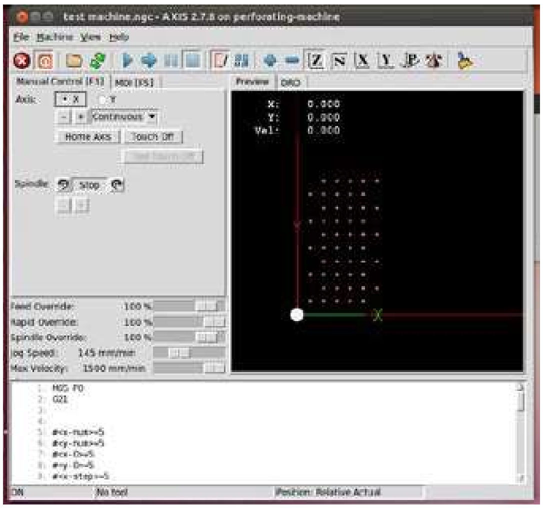
a b
c d

Fig. 3. Step Config: a - creating a new configuration; b - setting parameters and speed; c - assigning LPT port contact to the control signals; d - setup of the X axis

The AXIS graphical shell is designed to display the real-time execution of the program and the simulation of the machine, which is being developed before the perforation operation. This graphic shell is shown on the rys. 4.

The general look of a machine with two-coordinate movement system for the details perforation of the top of the shoes is shown on rys. 5. The main elements are: a device for performing a two-coordinate movement of the shoe parts with a fixed linear electric motor designed for perforating the shoe parts; stepper motor control system; stepper motor driver power supply unit and linear electric motor control.





a b

Fig. 4. AXIS Graphic Shell: a – the start of the program;b - the end of the program

The principle of the developed machine is as follows. The top detail of the shoe is placed on the desktop. Before that, with the help of the developed software, a necessary drawing is created for the perforation operation. The machine is put into operation and according to the developed program, with the help of a punch of a linear electric motor, the perforation of the part takes place.

You can perform the operation of marking parts or products by replacing the punch with a needle and creating a corresponding.

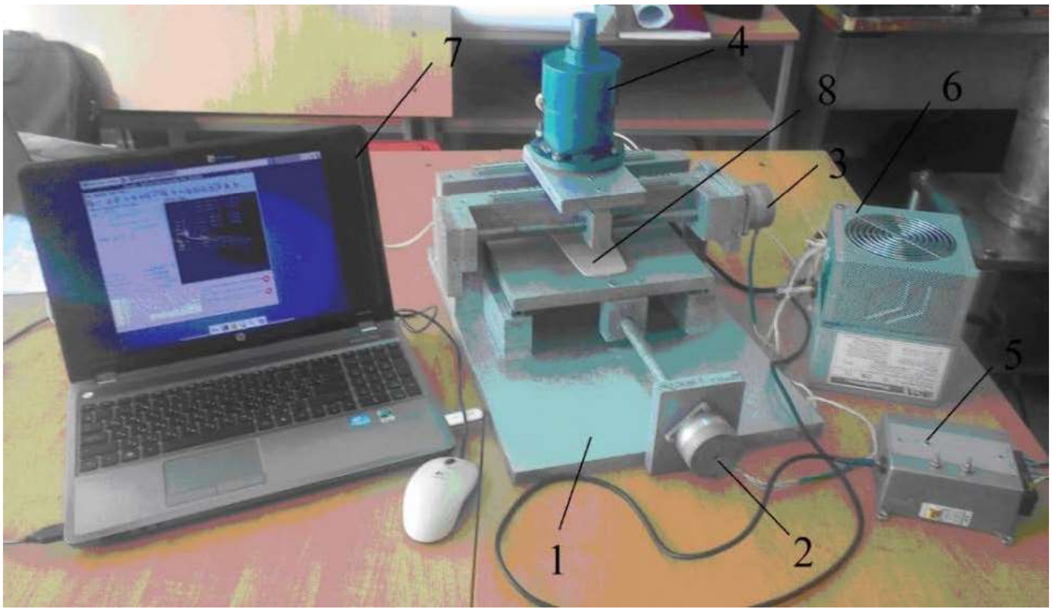


Fig. 5. General look of a machine with two-coordinate movement system for perforating parts of the top of the shoe: 1 - frame; 2-system of moving in coordinate Y; 3-system of moving along the coordinate X; 4-line electric motor; 5 – power and control supply of LEM; 6-stepper motor drive power supply; 7-electronic calculating machine (ECM); 8-detail

The developed mechatronic installation is a new tool that allows expanding the use of CNC devices in various industries, and also provides the moving of the actuator in a two-coordinate system along a complex contour.

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