PROCESSING EQUIPMENT EDM WITH CONTACT BREAKS

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ABSTRACT: The paper deals with the research, realization and modeling of a portable EDM equipment with contact breaking that is used in the processing of materials using unconventional technologies. The stages of making the equipment are presented as well as all the components used, detailed in an execution drawing and 3D modeled. Comsol Multiphysics was used to model the coil and simulate its operation.

Key words: EDM, contact breaking, conceptual and detailed design.

1. Processing using EDM with contact breaks

Electric discharge processes are the most widespread nonconventional processes in the world. Contact-breaking electrical processing is a process widely used for cutting conductive materials using mainly a solid tool-electrodes. We are witnessing a continuous evolution in the use of new types of metallic materials and the growth of new modern technologies in fields such as aeronautics, automotive, car construction, etc., using so-called unconventional technologies in which materials processing is done by using and directing energy in various forms. [1], [2], [3]. Through this research, it is desired to transmit a special approach regarding the modeling of the technological parameters for the processing with electric discharges with contact brackets, using a transfer object formed by a copper electrode, using an installation formed by an electromagnetic coil, a capacitor that stores electricity and a direct current generator.

2. State of the art

The purpose of EDM is to cut the metal into small sparks. Its advantages are that it will drill holes in metals that cannot be machined by common tools. Cutting of hard steel alloys by electric discharge machining with contact break with electrode tools - metal strip - is one of the modern technological procedures for conventional processing of certain categories of steel alloys (hard and extra hard), in economic conditions of optimum efficiency. [4], [5], [6], [7]. We can highlight the existence of different values of the working parameters, determined by the workpiece. The tool, usually made of copper or graphite, and the workpiece are connected to the poles of a power source. The material of the part is removed by the action of vaporization of the electric discharges in the form of sparks that take place between the tool electrode and the part electrode. The tool usually has the shape of the negative cavity that needs to be processed into the piece, and this can take many very complex shapes. The mechanical part, the head, is simple and portable, but precise, made of copper. The very high current is concentrated in a small point on the workpiece and the metal melts. The molten metal in the workpiece immediately solidifies into the dielectric fluid. Fresh dielectric fluid is continuously pumped to remove metal particles that are separated there by a filter that allows the dielectric to be recycled.

Materials to process:

• Any material that conducts electric current, regardless of its hardness, can be machined by EDM.

• Used mainly for alloy and high-alloy steels, especially for machining die cavities.
• The melting temperature of the processed material and the latent heat of melting are important properties that determine the material removal rate (MRR), which gives the productivity of the process. [8], [9]

3. Identifying Market Opportunities

N1: Customer needs portfolio
N2: The need to process materials by unconventional processes
N3: The need to remove broken tools
N4: The need for small, portable and inexpensive equipment
N5: The need to process materials that have a high hardness.

3.1 Opportunities/ Products / Clients

a) Market opportunities:

For N1:

Need to be a small and portable equipment

For N2,N4:

Processing of materials with high hardness

For N3:

Low cost of processing materials

b) Customers for the sale of products:

-Research institutions;
-Micro-enterprises;
-Small and medium enterprises;
-Large enterprises.
-Individuals
-Repair workshops

3.2 Competitive products

There are already competing products on the market at very affordable prices and with an average accuracy, but our product will tend to be one of very high accuracy, being able to be directed electronically and with multiple working heads, which competing products do not offer. working electrodes in several variants.

Fig 3.2.a Competitor products

4. Conceptual design

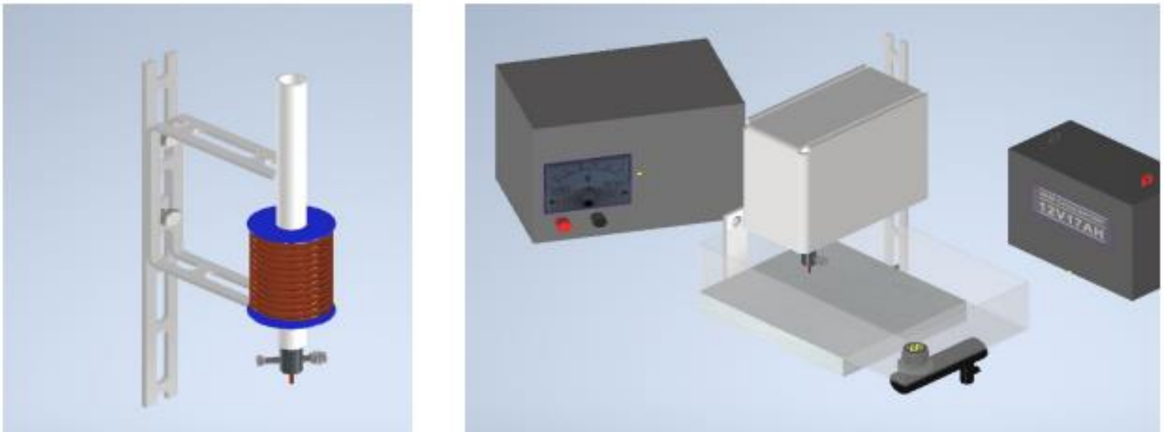


Fig. 1. 3D Modeling of working head and assembly with current generator and supplying battery 12V

The model of the work head and the support was made in Autodesk INVENTOR according to the real dimensions and the calculated data. In fig. 4.3 the execution drawing of the work head is made with the afferent dimensions and the notation of the components.

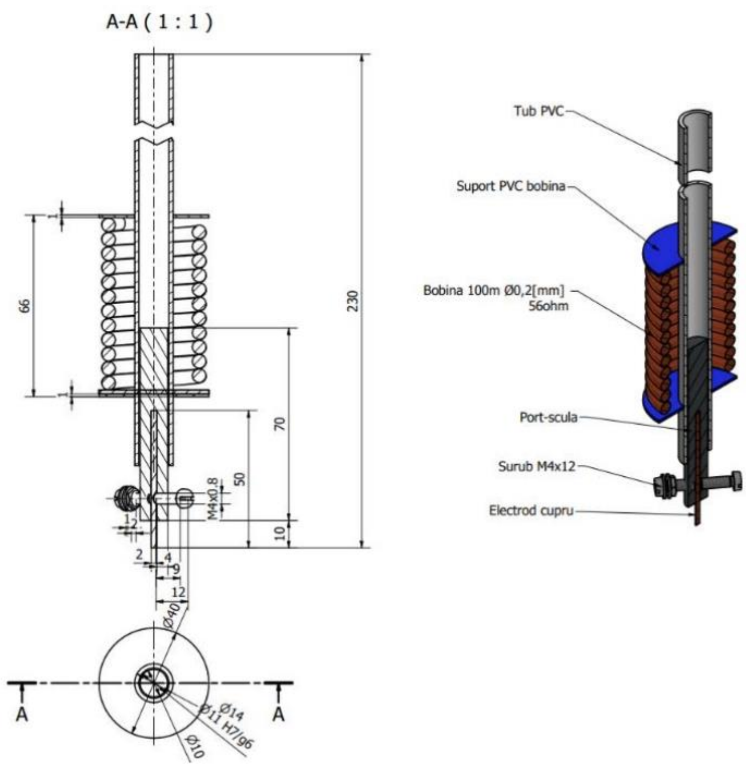


Fig 4.3 Design of the working head

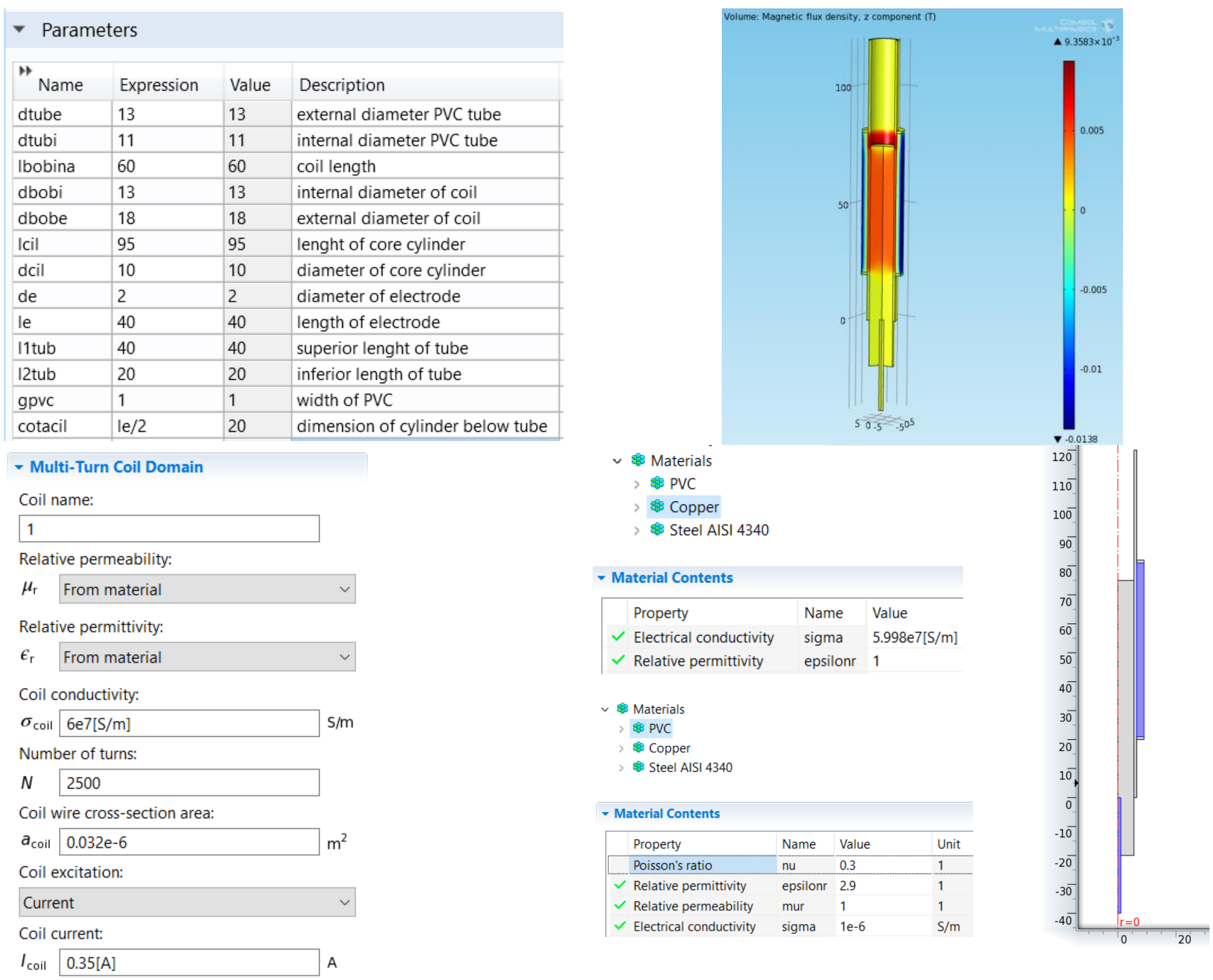
The project consists of several work heads that will be attached:

- circular shape of different diameters
- square shape of different sizes
- other shapes such as triangle, rhombus, ellipse

Fig. 4.4 Shapes of tool-electrode

5. Working head

Before making the coil, a numerical calculation was performed in the COMSOL Multiphysics program to determine the coil characteristics. fig. 5.1.



Parameters

Name	Expression	Value	Description
dtube	13	13	external diameter PVC tube
dtubi	11	11	internal diameter PVC tube
lbobina	60	60	coil length
dbobi	13	13	internal diameter of coil
dbobe	18	18	external diameter of coil
lcil	95	95	lenght of core cylinder
dcil	10	10	diameter of core cylinder
de	2	2	diameter of electrode
le	40	40	length of electrode
l1tub	40	40	superior lenght of tube
l2tub	20	20	inferior length of tube
gpvc	1	1	width of PVC
cotacil	le/2	20	dimension of cylinder below tube

Material Contents (Copper)

Property	Name	Value
Electrical conductivity	sigma	5.998e7[S/m]
Relative permittivity	epsilonr	1

Material Contents (PVC)

Property	Name	Value	Unit
Poisson's ratio	nu	0.3	1
Relative permittivity	epsilonr	2.9	1
Relative permeability	mur	1	1
Electrical conductivity	sigma	1e-6	S/m

Fig. 5.1 Characteristics of the working head

In Fig. 5.1 the parameters of the coil, of the PVC shaft, the details about the electrode and the copper wire from which the coil is made were introduced. Fig. 2.3 represents the force of the coil on the metal rod in which the copper electrode is attached, we can see the red surface where the highest magnetic force takes place.

Respectively in Figs. 2.4 we have the conductivity of the wire, the number of windings, the cross-sectional area of the wire and the current passing through the coil: 0.35A. Fig. 2.5 represents the electrical characteristics of the coil.

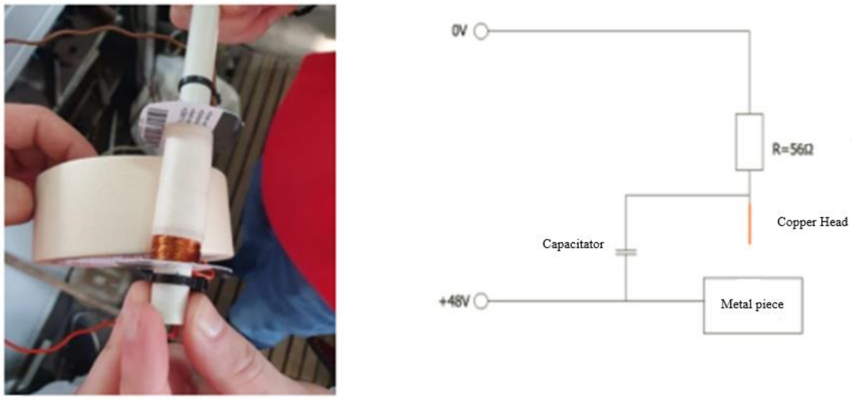


Fig. 5.2 Wiring diagram

Winding calculations were performed which led to the realization of the coil using the following formulas:

$$R = \rho \frac{l}{s} \quad [1]$$

- l= length of winding wire [m] l=100 m
- ρ= wire resistivity $[\Omega \frac{mm^2}{m}]$ $\rho(cupru) = 1{,}68 * 10{-}8\ [\Omega m] = 0{,}0168[\Omega\ mm2\ m\ ]$ [2]
- S= Cross-sectinal area mm^2 S=0.03 mm^2
- Winding wire diameter: Db=0,02[mm]
-Length of winding wire: L=60[mm]

Coil resistance calculation:

$$R = 0{,}0168 \frac{100}{0.03} = 56[\Omega] \quad [3]$$

The wiring diagram contains a coil, a copper electrode, capacitor and circuit power supply. The circuit has a 48V supply, the negative pole enters through the coil, then passes through the capacitor which is in the circuit with the electrode, following that the positive pole is connected to the workpiece and to the other end of the capacitor, thus storing electricity.

Client: Mircea Petre **Adress: Branesti, Makita** **Phone:0722115566**		**Interview: Hatis Bogdan** **Data: 01.11.2012** **Ocupation: Production Manager**	
No.	Questions	Client Answeans	Interpreted needs
1	What field do you work in?	Production engineer	The need to increase the precision of tool guidance
2	Do you use EDM processing equipment at your job?	I do not use any such equipment	- The need to increase the quality of the processed surface;
3	What are the disadvantages?	-inefficient dielectric washing of the work area; - difficult orientation of the lamella tool relative to the machining surface;	The need to increase the precision of tool guidance

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4	What do you think about EDM equipment?	-increases the productivity of processing by simultaneous processing; - allows efficient washing of all processing gaps;	-The need to increase the quality of the processed surface
5	What do you think about using this type of equipment?	I would use such equipment because it has very important advantages	-The need to increase the quality of the processed surface
6	What are the most common types of materials you use for processing?	Alloy steels	-The need to increase the quality of the processed surface
7	What are the most used operations?	Hole processing	The need to process high quality holes
8	Would you like to buy such equipment?	Yes, I would like to buy an equipment	-The need to increase the quality of the processed surface

6. Conclusion

The results of finite element modeling in the dedicated Comsol Multiphysics software allowed the sizing of the work head. Subsequent research will address the realization of a working head with an electromagnetic coil that allows to widen the range of regimes by increasing the current, corresponding to some roughing and semi-finishing processing as well as using different shapes of tool-electrodes.

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