

CONSTRUCTIVE SOLUTIONS FOR HYDROSTATIC EQUIPMENT USED AS FEED MOTION REPLICATE AT ELECTRICAL DISCHARGE MACHINING

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ABSTRACT: The paper reveals the technical solutions adopted for the design of hydrostatic equipment to replicate the electro discharge machining feed motion. Such equipment is very usefully in, at least two cases. A first case is when machining by electro discharge in difficult angular positions, in order to avoid using special fixturing devices. Using such device can result in significant costs reduction. A second case refers to the case of machining oversized workpieces, which cannot be installed on medium or small sized usual electro discharge installations. Based on functional specifications and elaborated technical documentation, a fully functional model was achieved. Experimental tests revealed a good accordance between the performance requirements and measured ones. The equipment is working properly, from the point of view of EDM system command response both in continuous and pulsed regimes. Further researches should be carried out on equipment with multi-place operation mode.

KEY WORDS: universal EDM equipment, feed motion replicate, hydrostatic device, constructive variants.

1. INTRODUCTION

Very large work pieces (like oversized heavy crankshafts, large housings etc.) can be machined by electro discharge (EDM) only on large-sized installations (corresponding with dimensions of the workpiece) and, of course, with high power consumption. When large horizontal or angled surfaces of workpieces are required, including oversized work pieces (which could not be

processed on conventional medium sized classic EDM installations) and also to avoid designing special fixturing devices, it can be used an equipment for replicating (copying and transmitting) of the EDM installation work head feed movement [1], [2]. It has to be mentioned that the equipment must be able to transmit the movement direction under different adjustable angles. The general setup scheme of the described equipment is presented in Figure 1.

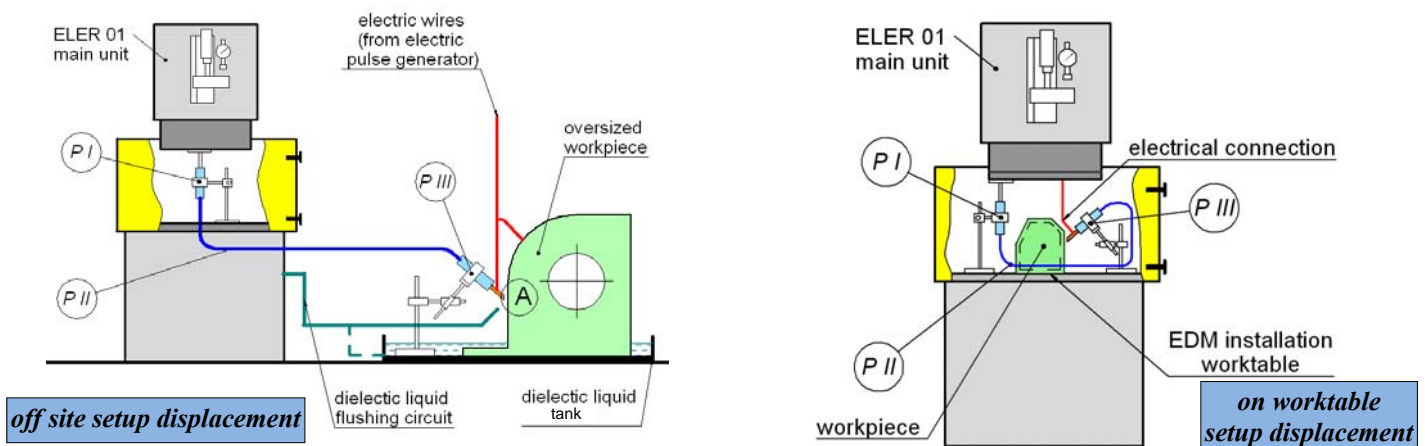


Figure 1. Equipment setup displacement cases

In order to assure the necessary conditions for development of EDM process, it is necessary to provide electrical connections (from the generator), dielectric supply circuit and hydraulic movement circuit as it is presented in Figure 1.

Thus, it can be accomplished basically, any electro discharge machining process (e.g. lubrication spindles holes deburring, crank pins of large crankshaft etc.) achieving also considerable savings both in financial and time terms.

The presented equipment consists of three distinctive functional parts, as mentioned below. A first subset component (*P I*) provides capturing the feed movements of the working head of the EDM installation. A second subassembly is the unit of motion transmitting (*P II*) to the execution unit (*P III*). The functional subassemblies and the two considered angular positioning cases are presented in Figure 2, where α is the angle between the work head direction and the machining angle.

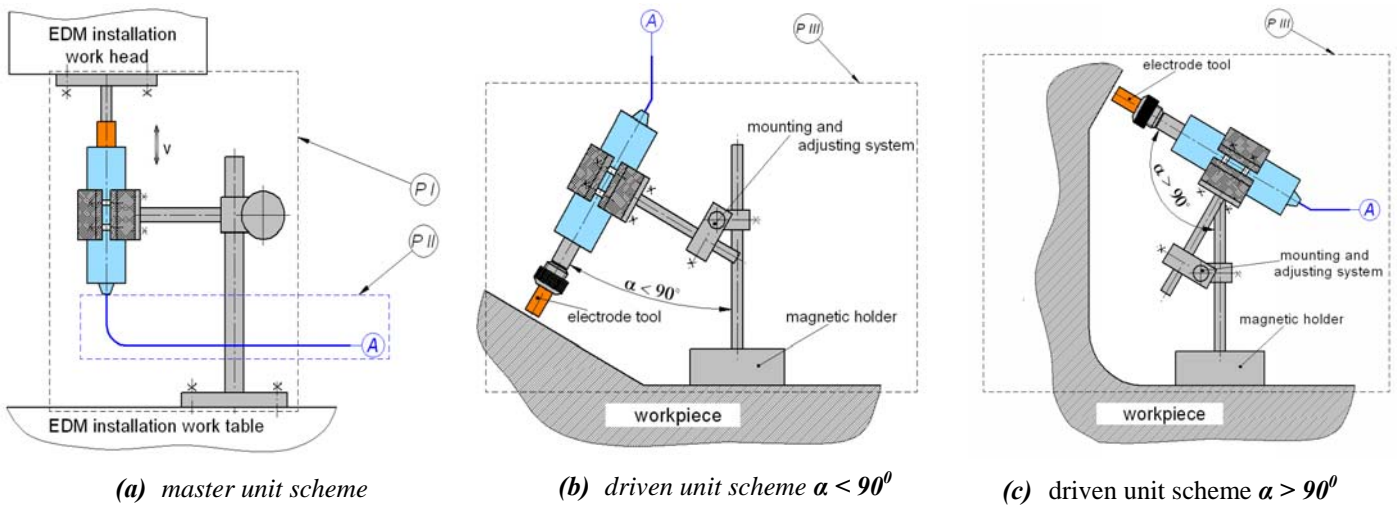
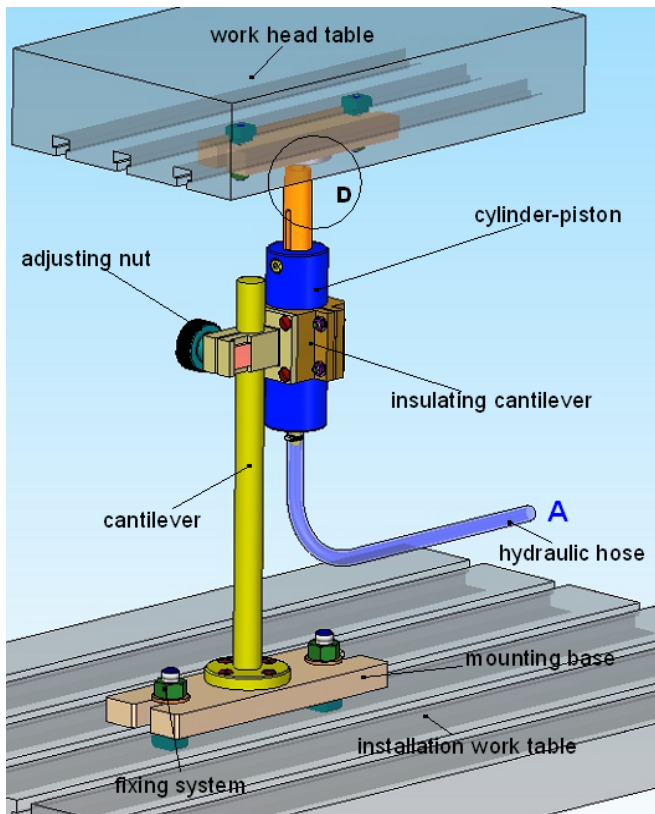


Figure 2. Master unit and driven unit under considered angular domains positions

2. MASTER UNIT SUBASSEMBLY

A general 3D overview of the master unit subassembly is presented in Figure 3, where its main components are indicated.



D – spherical joint detail view

Figure 3. Master unit 3D axonometric overview

Master unit (control) main parts are presented in Figure 5. Thus, Master unit subassembly consists of the upper plate 6 by means of which the movable piston 2 is fixed to the working head of the EDM installation, using two screws for T-slotted channels,

with washers and corresponding nuts (the presented constructive solution is designed for Romanian ELER 01 EDM installation). The upper mounting plate is provided with a spherical socket, which together with the spherical head of the piston 4 forms a ball joint allowing system self-adjusting, to compensate for any alignment errors that can generate additional frictional forces between cylinder walls and piston. The piston is provided with three small grooves (see Figure 4 - detail A), in order to maintain a lubricating oil film between the cylinder and the piston gap. The piston 4 is also provided with a longitudinal groove into which the screw 8 cylindrical head is conceived for limiting the stroke [3].

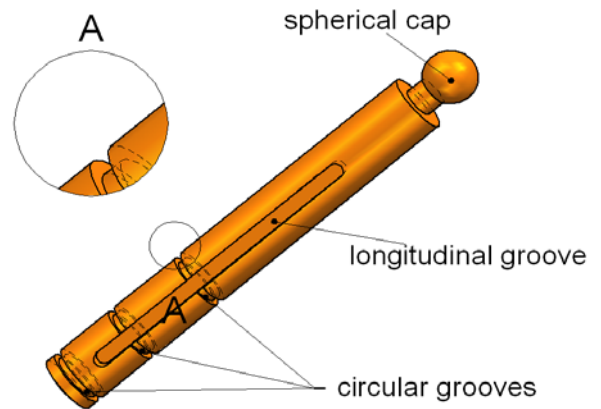


Figure 4. Piston constructive details

The cylinder 1 is firmly fixed to the installation work table via the connecting elements system (for adjustment and locking in position – see Figure 5.). The cylinder support (pos. 3 and 9) are made of electro-insulation material to prevent the occurring of electrical short-circuit between pulse generator poles. Support 12 allows sliding for position adjustment on column 14. After positioning support 12, it is blocked (obviously, all elements solidary with it) in desired position by special screw 11, a knurled nut 10 and elastic conical washer 19.

The entire assembly can be positioned on the installation work table and obviously on work head in any convenient relative position depending on the specific needs of the considered situation. Column **14** is fixed to the base plate **18** with screws **17**. Perpendicularity error of outer cylindrical surface of column **14** in relation with the work table (and all integral elements of subassembly) is also

compensated by the spherical ball joint recess formed in the upper plate **6** and the spherical head of the piston **4**.

Master unit subassembly is designed to replicate the advance motion generated by EDM installation (depending on the requirements of the machining process), transform into hydraulic differential pressure and transmit it to the execution unit (**P III**).

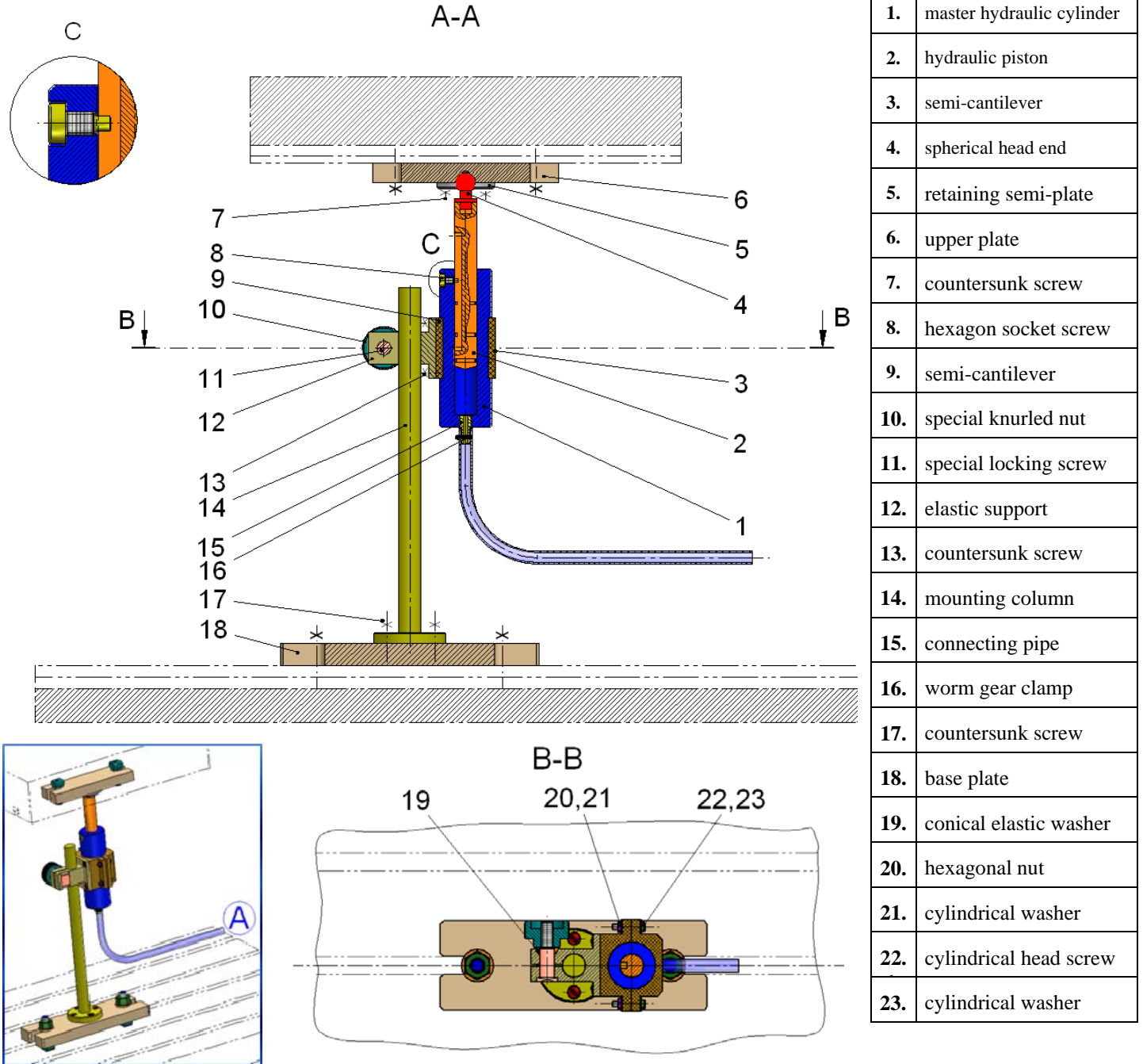


Figure 5. Main components of master unit subassembly

3. DRIVEN UNIT SUBASSEMBLY

3.1 Unique adjustable position variant

Driven unit subassembly replicates EDM working head feed (advance system), taken from the equipment master unit, using hydraulic transmission.

Its 3D model in axonometric overview is displayed in Figure 6. The construction variant of the considered subassembly is achieved in order to obtain 1:1 copying ratio (accurate motion replication). Thus, cylinder **8** is totally identical to that of the master unit (pos. 1 – see Figure 5).

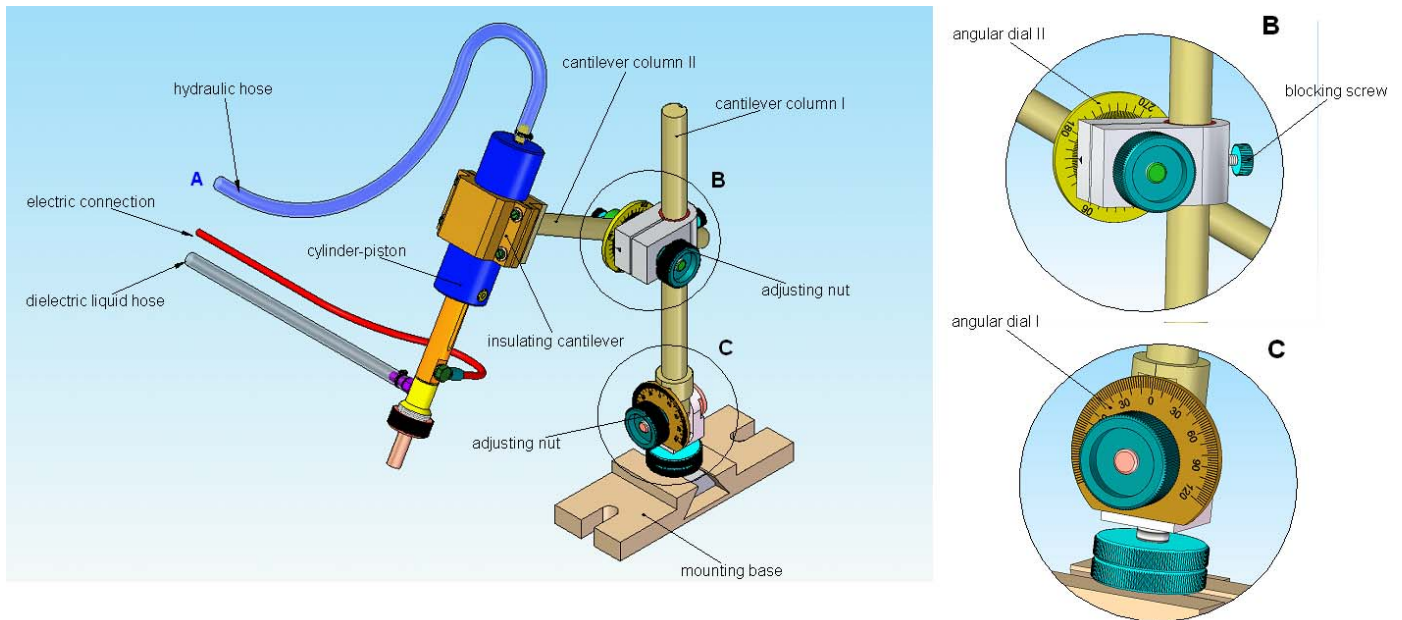
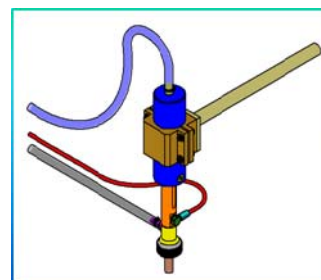
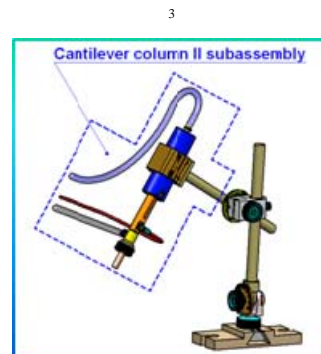
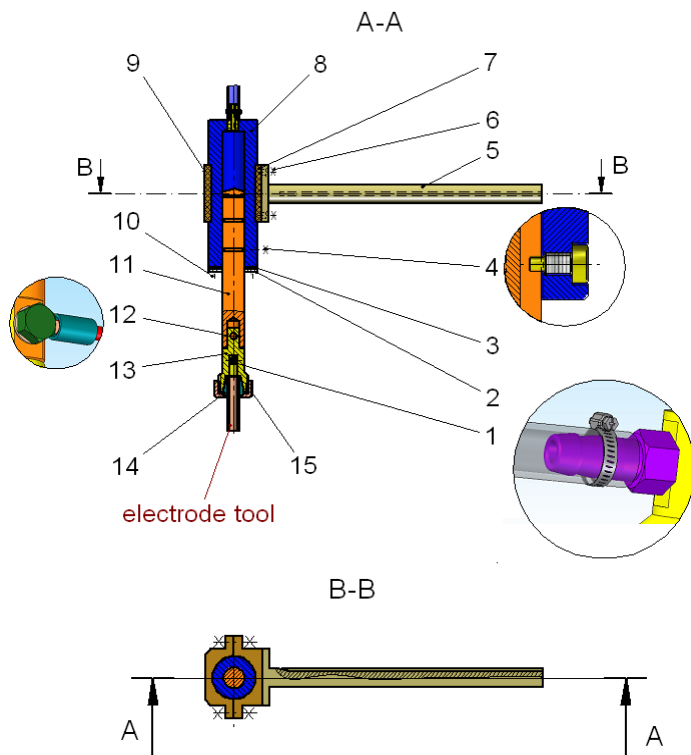


Figure 6. Axonometric 3D overview and details of driven unit subassembly

A portion of the piston *11* (Figure 7) could be immersed in dielectric liquid and resulting products of the electrical discharge machining could be deposited on its outer surface, which entered in the cylinder-piston gap, and damage its active surfaces.

Taken into account this fact, a felt gasket *3* (optional) may be provided with cleaning piston purpose [4]. The gasket is secured on the front face of the cylinder of the cover ring *2* by means of screws *10*.



1.	injection nozzle
2.	cover ring
3.	felt gasket
4.	hexagon socket screw
5.	cantilever column II
6.	mounting screws
7.	semi-cantilever
8.	driven cylinder
9.	semi-cantilever
10.	cover ring screws
11.	driven piston
12.	electrical connection
13.	electrode – tool holder
14.	clamping collet
15.	circular cap

Figure 7. Technical drawing. Cantilever column II – Driven unit subassembly.

The electric wire from the pulse generator is connected directly to the piston by bolt *12*. In case of machining process occurring off site, which makes the existing cable connection impossible or if it is too rigid (old) to insure the piston movement (preventing force lost), an extension of at least four

electrical wires of 1 mm^2 section each ($d_{\text{wire}} = 1.27 \text{ mm}$) can be adapted for. Electrode tool holder *13* is centred on the inner surface of the piston *11*, on accurate sliding adjustment matching (H7/h6 type). It is provided with a clamping collet *14* for the, tightened by a circular cap *15*. When machining with

tubular electrode tool, working gap flushing is done by attaching the hose between the injection nozzle *1* and the dielectric liquid supply unit of EDM installation. Driven cylinder *8* is mounted in two insulating semi-cantilevers *7* and *9* (solution identical to that used in master unit subassembly –

see Figure 3 and 5), for electrical insulation of the pulse generator poles. Cantilever column *5* is mounted on the insulator support *7* by screws *6*. Adjusting possibilities of driven subassembly are provided by the entire guidance system (see also Figure 8) [5].

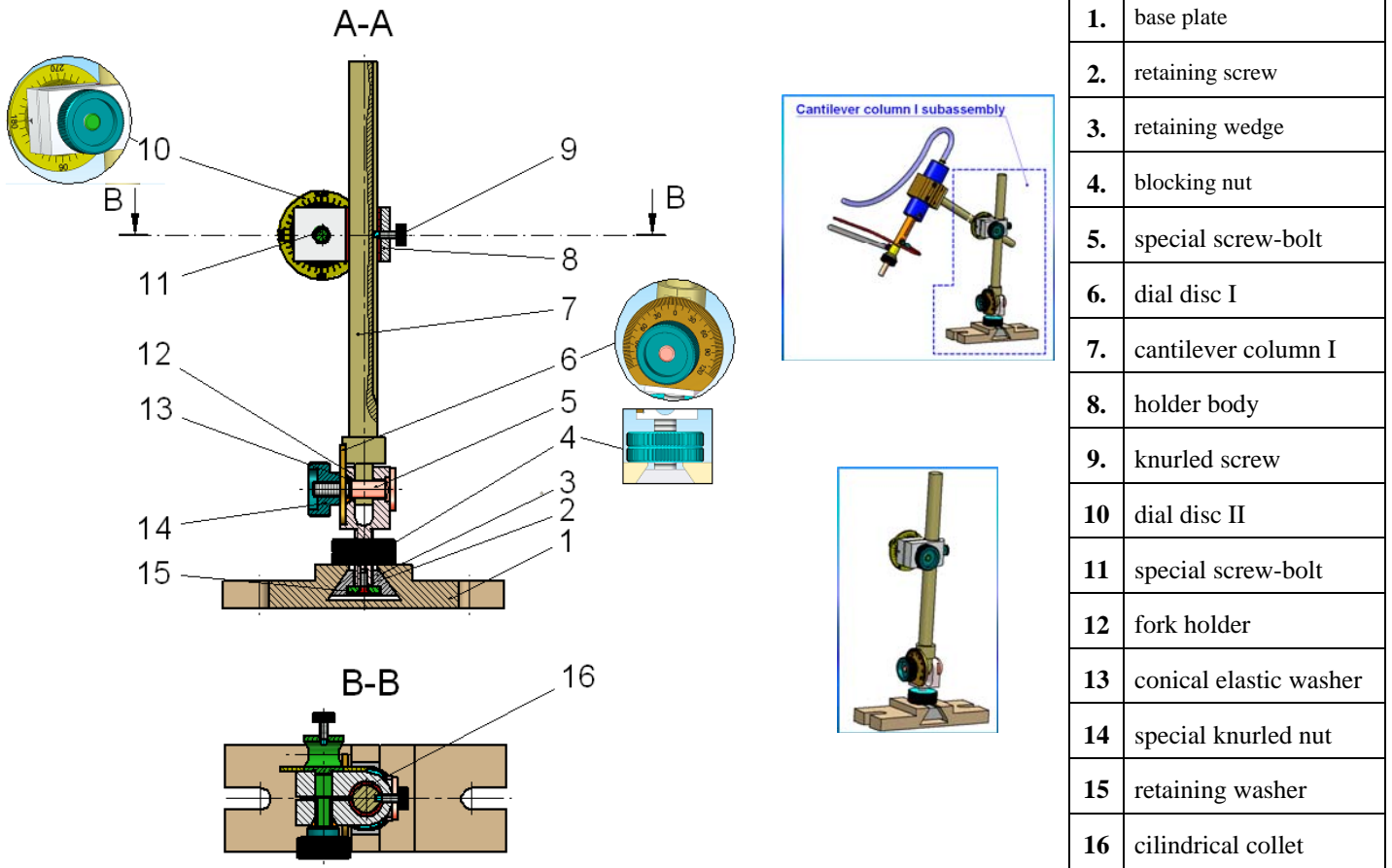


Figure 8. Cantilever column I – Driven unit subassembly.

Electrode tool leaning is calibrated using dial disks *6* and *10* aiming at obtaining machining position relative to the workpiece, determined by the other opportunities: by moving and rotating the displaceable column *5* (see Figure 7) along the screw hole *11* (see Figure 8); displacement of holder *8* on the column *7*; entire subassembly rotation around the axis of the fork holder *12*; displacement of execution system with column *7* and fork holder *12* on the base plate *1* etc. Blocking of those movements during machining process is obtained by knurled screws *9* (see Figure 8.) for column *5* positioning (according to Figure 7.) and respectively for holder body *8*, for the others possibilities of adjusting by tightening the blocking nuts *4* (Figure 8.).

The presented variant of driven subassembly is intended to be used for machining on EDM installation worktable. The constructive variant provides a quick and easy adjustment of the required processing angle, overall positioning accuracy being relatively low [6].

As an optional guidance system for off-site machining, a magnetic holder can be used, with the advantage of fixing on any flat metal workpiece or another additional work holding system (Figure 9.).

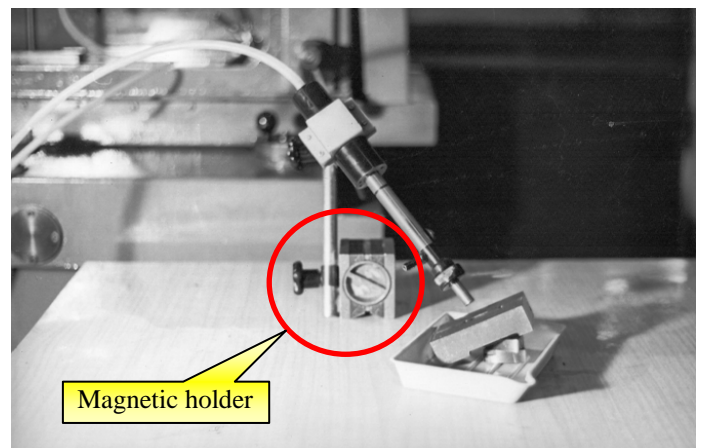


Figure 9. Magnetic holder system variant

In case of surfaces which require a higher machining precision as well as of planar arrays/structures machining (with a high positioning accuracy), the variant described below can be used.

3.2 Planar arrays adjustable variant

The proposed constructive variant is shown in Figure 10. As it can be noticed, the stroke (in both directions X & Y) on the EDM installation worktable plane are controlled by micrometer heads, which ensures an accuracy of **0.01 mm** and an active stroke of **25 mm**. Movement is done on **T**-shape guide ways with wringing fit. The presence of

traction springs is noteworthy that ensure a permanent contact between micrometer heads tracer stylus with slide system in both directions.

All possibilities of rotation are visualized on angular dial disks and optionally provided with graded scale on the fixed part; $0^{\circ}20'$ positioning accuracy can be achieved.

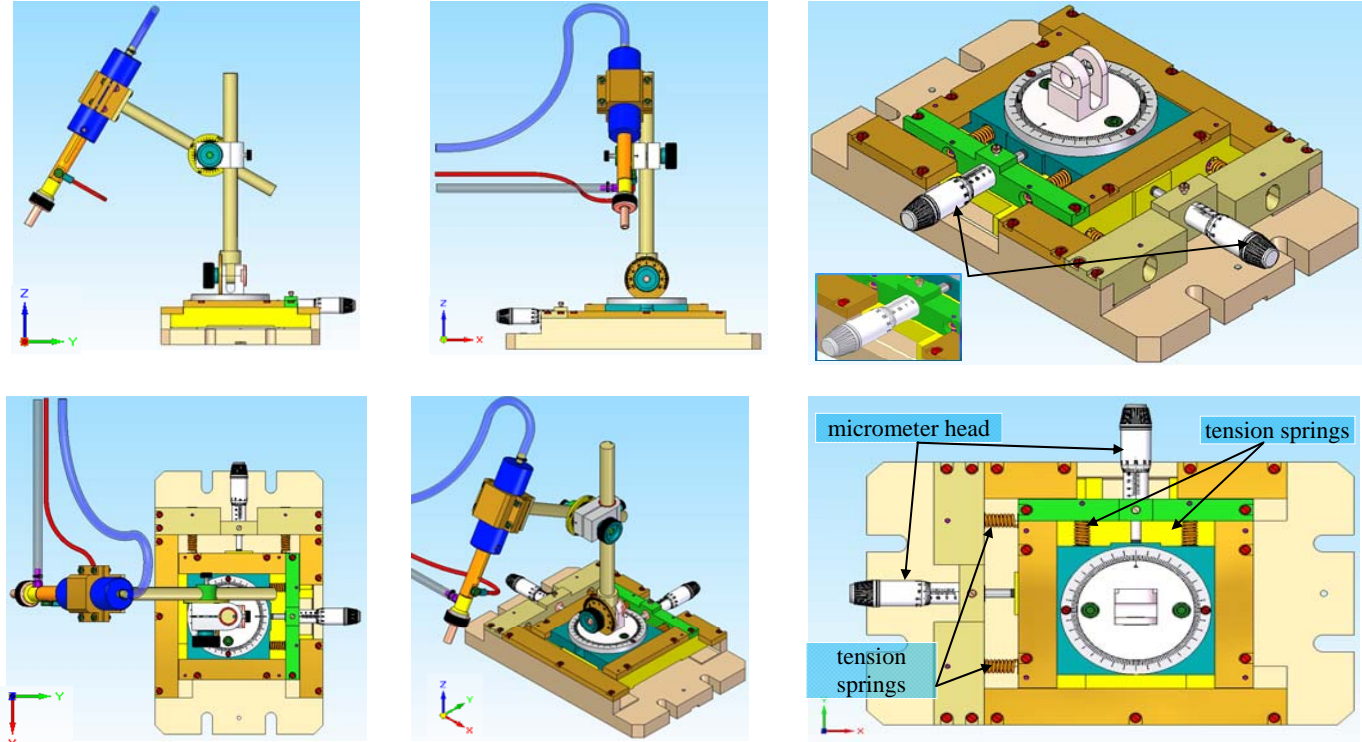


Figure 10. General assembly and micrometric table views

4. CONCLUSIONS AND REMARKS

Fully functional model of a hydrostatic system was achieved that replicates the feed movement of work head at electrical discharge machining (Figure 11). Various constructive solutions were achieved proving that needed precision is attained for different machining cases as difficult angular

positions, over sized parts, planar structures etc. Further researches will be focused on equipment dedicated to with multi-place operation mode, aiming at increase precision and surface quality too.

6. ACKNOWLEDGEMENT

These research results are obtained in the frame of Partnership Project, HighTechMicroEDM+US.

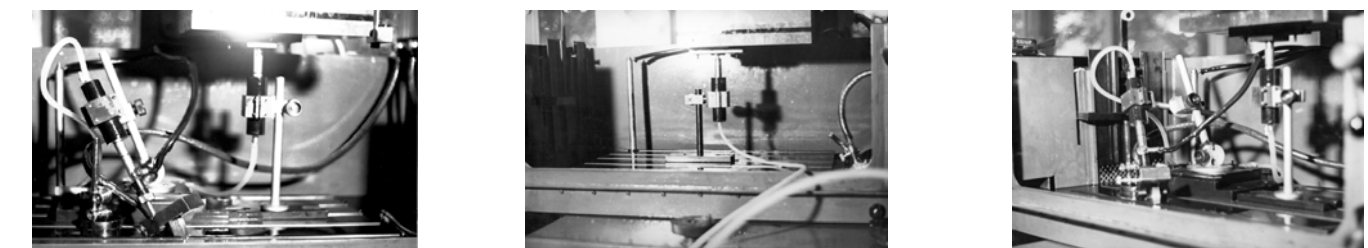


Figure 11. Fully functional experimental model, on worktable of ELER 01 EDM installation

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