# A Stand for Functional Testing of Keyboards

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*Abstract* – **A stand for automated functional testing of keys used in keyboard data input is described. The stand design is analyzed by defining the initial conditions for designing the electromagnetic driving. A model of the electromagnet has been created.**

*Keywords* – **Stand, Functional testing, Keyboard, Electromagnetic driving, Magnetic field modeling.**

## I. Introduction

Keys and keyboards for manual data input to a PC are a basic technical means for performing the man - machine interface. They are not expected to be replaced by another technical solution in the near future [2].

Every keyboard manufactured should be subject to a functional test intended for verifying its correct performance. For this purpose it is necessary to create a technical means providing a high rate of key actuation during the test, eliminating the influence of any subjective factor.

## II. Analyzing the Stand Design

The existing requirements for the geometry of keys and keyboards in accordance with the international standards determine the design configuration of the stand. Correspondingly, a stand has been developed which meets the following requirements:

- individual electromagnetic driving of each key, which is achieved by using an appropriate software solution;
- placing the keys in keyboards in lines, and their corresponding driving mechanisms should be located in accordance with the key configuration;
- a precise distance between individual keys (19 mm) that will determine the of driving mechanism geometry;
- a free stroke of the key equal to 4 ± 0.5 mm;
- initial effort of key actuation: 0.4 ± 0.25 N;
- final effort of key actuation : 0.8 ± 0.35 N.

Under observing the above conditions, it turns out that most suitable for driving the individual keys are the pulse-controlled electromagnetic mechanisms of solenoid type [2, 3].

The electromagnets are separated in an autonomous functional assembly. The general appearance of a stand with electromagnetic key driving is illustrated in Fig.1.

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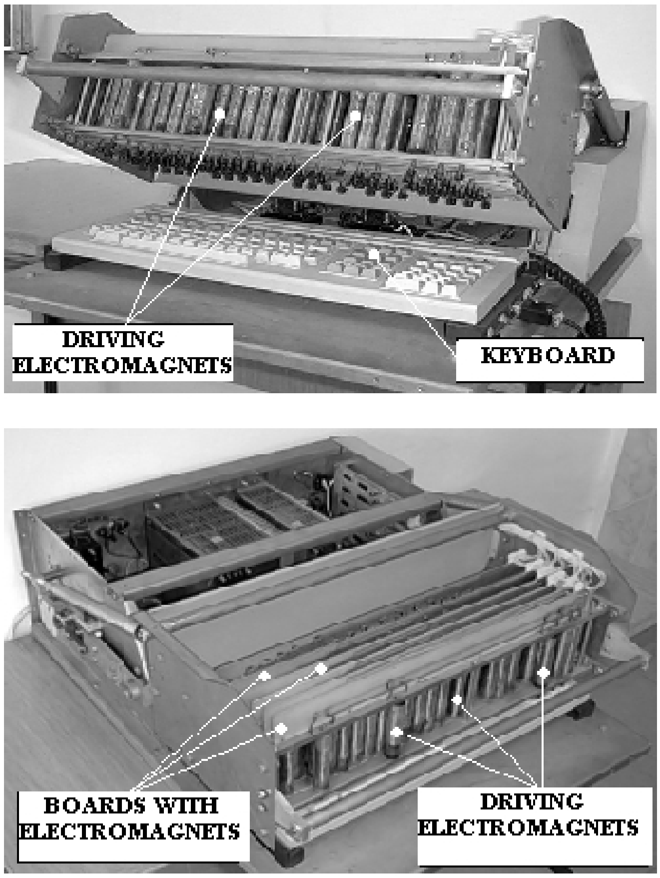


Fig.1. General view of the stand.

The electromagnet driving involves the combination of a key and electromagnet, which means that the key spring plays the role of a return spring, Fig. 2. Therefore, the electromagnet armature should not be heavier than the initial effort of key actuation.

The final force of the electromagnet should be greater than the final effort for key actuation. The maximum travel of the electromagnet should correspond to the free stroke of the key.

The analysis of the stand design made by taking into account its geometry defines the initial data for designing the driving electromagnets.

The parameters of a driving electromagnet are:

- the supply voltage being 12 V;
- the current pulse amplitude: 1.4 A;
- the current density: $j = 11$ A/mm$^2$;
- the wire diameter: $\varnothing = 0.45$ mm;
- the turn number: $w = 1540$ turns;
- the power supply is of pulsed type.

The pulsed control makes it possible to use a software program for performing 1-, 3-, 5-, or 10-fold actuation of each individual key as well as its forced actuation.

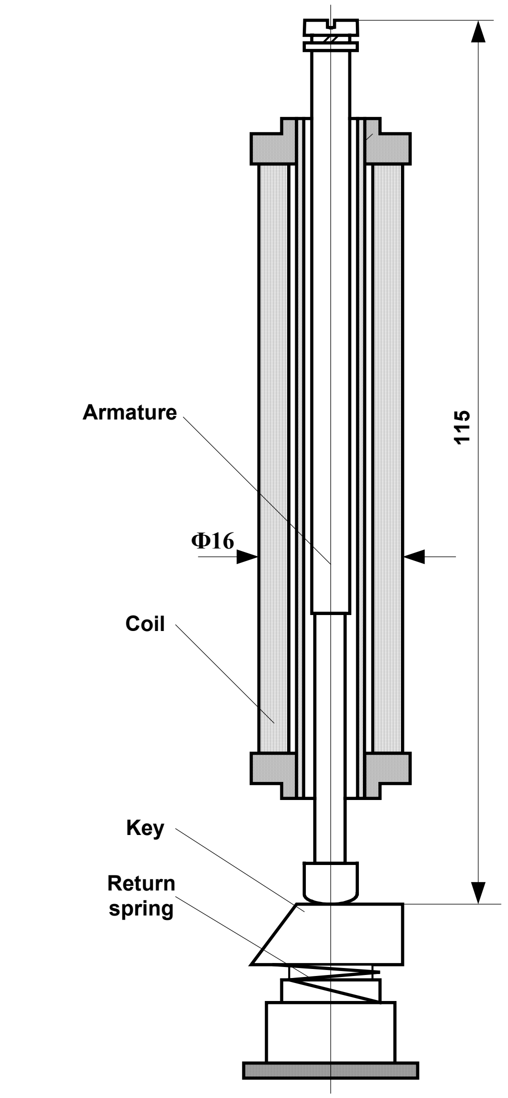


Fig. 2. Individual electromagnetic driving of a key from the keyboard

Fig. 3 shows the form of pulses for 10-fold actuation of the key this being the working mode of heaviest loading.

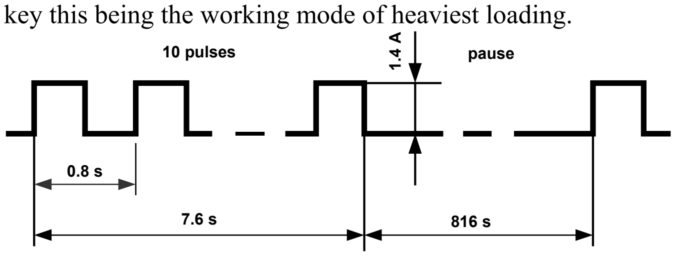


Fig. 3. The form of pulses for 10-fold actuation of the electromagnet.

The main task of the present work consists in carrying out an electromagnetic analysis by obtaining the values of the initial and final forces of key actuation.

## III. Theoretical results

The magnetic field distribution in the solenoid electromagnet is modeled using finite element method (FEM). Two cases are investigated – for the initial position of the electromagnet's armature, illustrated in Fig. 4 and for the final position of the armature (4 mm movement). It was found that the maximum value of the magnetic field density $B_{max}$ is in the middle of the armature for the both cases investigated.

It was also found that the solenoid electromagnet does not cause electromagnetic interferences in the adjacent electromagnets.

The magnetic force of the electromagnet is estimated using Maxwell's Stress Tensor. For the initial position of the armature it is $F_i = 0.36$ N and for the final position – $F_f = 0.61$ N. Compared with the initial requirements to the electromagnet, sited above it is obvious that these values of the force absolutely satisfy these requirements.

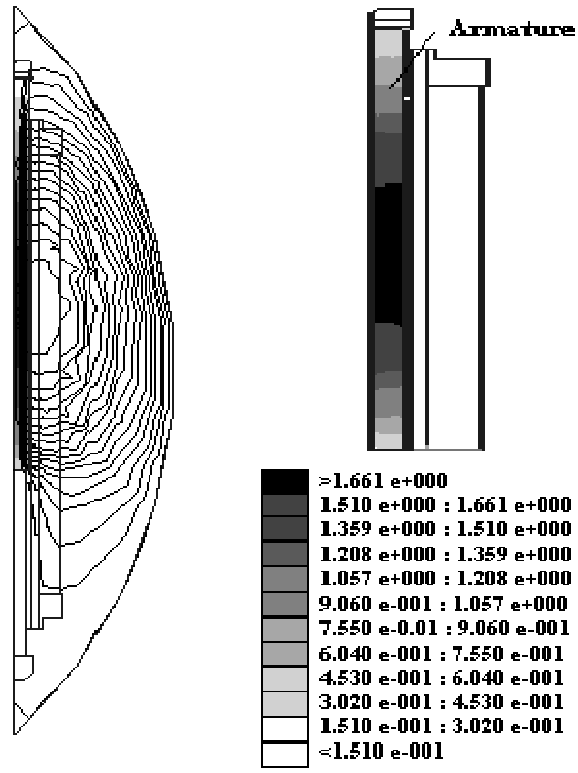


Fig. 4. Magnetic field density B distribution for the initial position of the armature

## Conclusions

1. A technical device – a stand for functional testing of keyboards – has been realized.
2. The magnetic field of the electromagnet for individual driving of the keys has been modeled.
3. The analysis of the magnetic field model created and the results obtained for the initial and final actuating forces are in accordance with the preset requirements for the electromagnet.

## References


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