Power electromagnetic strike machine for engineering-geological surveys

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Abstract. When implementing the processes of dynamic sensing of soils and pulsed non-explosive seismic exploration, the most common and effective method is the strike one, which is provided by a variety of structure and parameters of pneumatic, hydraulic, electrical machines of strike action. The creation of compact portable strike machines which do not require transportation and use of mechanized means is important. A promising direction in the development of strike machines is the use of pulsed electromagnetic actuator characterized by relatively low energy consumption, relatively high specific performance and efficiency, and providing direct conversion of electrical energy into mechanical work of strike mass with linear movement trajectory. The results of these studies allowed establishing on the basis of linear electromagnetic motors the electromagnetic pulse machines with portable performance for dynamic sensing of soils and land seismic pulse of small depths.

1. Introduction

The current situation in Russia brings to design engineers an urgent task of creating competitive technology for advanced technologies in construction, mining, engineering – geological researches.

Newly created types of equipment should be more productive, smarter, more reliable, easier and cheaper manufactured similar products. This contributes to realization in the new machines innovative approaches and design solutions, wide application at their stage of development and design of the numerical experiment, which reduce the complexity and increase the efficiency of works in creation of new equipment.

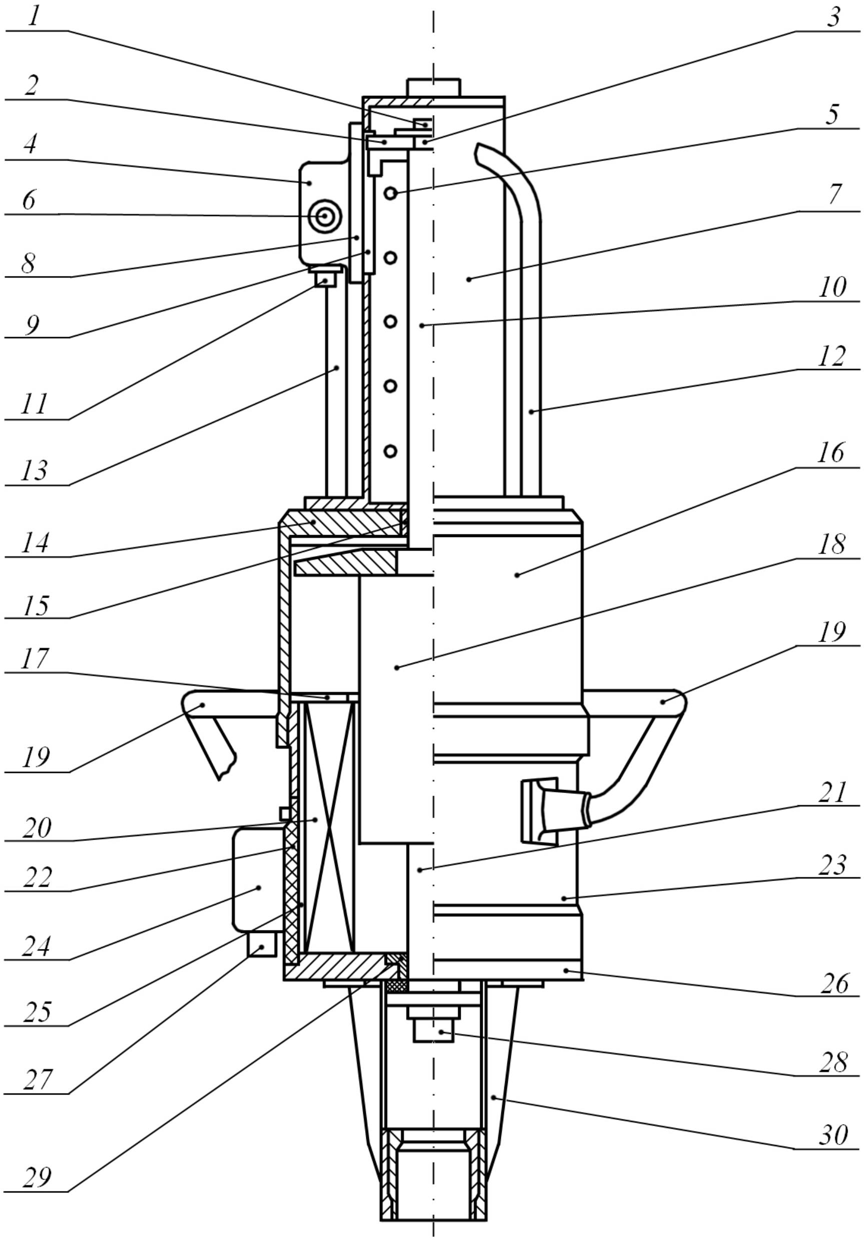
When implementing the processes of dynamic sensing of soils and pulsed non-explosive seismic exploration, the most common and effective is the strike method [1, 2, 4, 5].

Analysis of technical means, conditions and methods of operation in a pulsed non-explosive seismic exploration of small depths and dynamic sensing of soils shows that for a certain range of energies, frequency bumps, pulsed electromagnetic strike machines are able to make successful competition with the traditional gas-dynamic, hydro - and pneumatic-mechanical devices [1, 6-8].

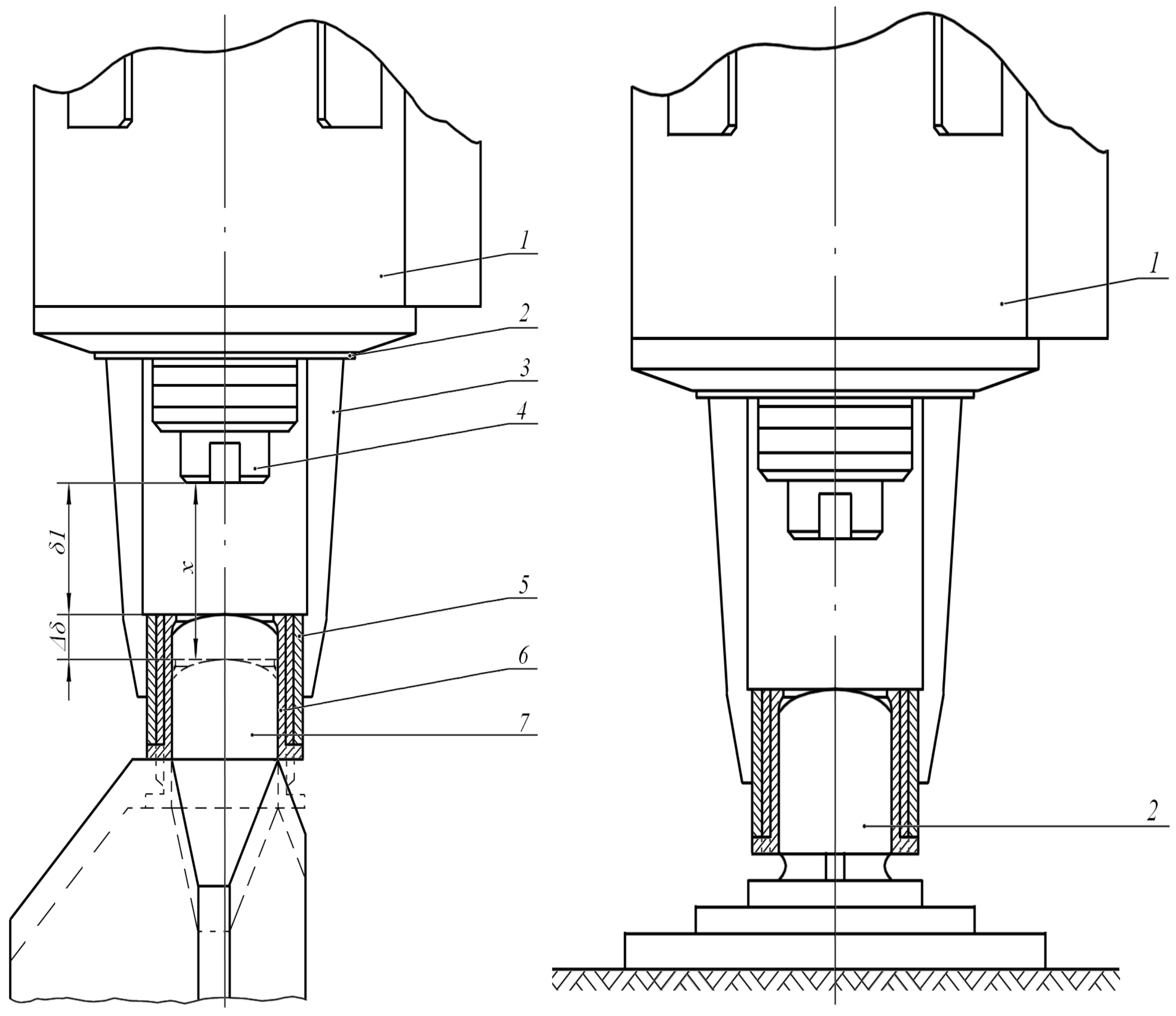
The results of these studies allowed establishing on the basis of linear electromagnetic motors electromagnetic pulse machines with portable performance for dynamic sensing of soils and land seismic pulse of small depths.

2. The object and method of research

The proposed design of a pulsed electromagnetic strike machine as well as components of coordination and transfer of mechanical energy is shown in figure 1. In magnetic core 23, cylindrical multilayer winding 20 is mounted. Fixation of the winding from the possible movements provided by retaining ring 17 and base 26, which is fastened to the yoke with six screws M10.



a



b c

Figure 1. Portable electromagnetic strike machine (a) and nodes of coordination and transfer of mechanical energy (b, c).

For easy mounting of the conclusions of the winding in the magnetic circuit, axial groove 25 is provided, also reducing eddy currents in the housing of the linear electromagnetic motor. The conclusions of the winding connected to the supply wire M10 studs that are installed on textolite base 22 and closed casing 24. The input seal is ensured by seal 27 and rubber seal between the body of the linear electromagnetic motor and textolite base 22.

Motor armature 18 combined form has the top 10 and bottom 21 guide rods, which move freely in the bronze bushings 15, 29, and is pressed into guide housing 16 and base 26. On the lower end of the rod, the set is made of alloy steel firing pin 28, which prevents unriveting of this rod.

To reduce the weight of portable machines, upper guide housing 16 is made of aluminum alloy and has a welded construction. To extend this element of cover 14 exposed at work to cyclic loads from the action of the return spring 5 has a larger, in comparison with the wall section. When assembling, the guide body 16 is screwed to the magnetic circuit 23. Pre-preloaded return spring 5 is put on the upper guide rod 10 and is fixed by focus with washer 1 [2, 3].

Characterized by dynamic sensing of soils customary mode with maximum striking power is implemented through the self-oscillating method of controlling a linear electromagnetic engine with feedback on the status of the striker. For this purpose, the engine is equipped with sensors that can detect the limit position of the armature and control the operation of the linear electromagnetic engine. It is most convenient to place the block of sensors on housing 7, closing return spring. In this case, the design of the engine without any changes, access to sensors for maintenance and replacement are extremely simplified. As the sensors make a research within only the control signals and are low voltage elements, they are compact and do not affect the dimensions, weight and specific indicators of the product [9, 10, 11, 12].

Control sensors 4 are structurally simple. In the upper part of rod 10, neck 3 is provided, with freely planted textolite slider 2 with spring-loaded copper-graphite brush (not shown). The contact plate of textolite sensors are mounted in the housing 8, which is installed in rectangular window 9 of the casing 7 of the return spring. The brush is preloaded with its spring to the flat surfaces of the housing 8 and contact plates and slides thereon during the reciprocating movements of the rod 10, closing one or the other pair of plates in the end positions of the armature.

In a thin-walled metal housing 4 that protects the sensors from adverse impacts, connector 2 connecting the control cable and toggle switch 6 controlling the hammer are mounted. All items are sealed by rubber gaskets.

Machine with portable performance for dynamic sensing of soils provides strike energy of 400 Joules, strike rate of up to 480 min^{-1} and are designed for use with rechargeable power source.

Rare single shocks mode with a maximum energy of the strike characteristic of the pulse source of seismic vibrations, is easy to implement with the help of a more simple, without feedback on the status of the striker method of controlling a linear electromagnetic motor, and therefore, the sensor unit 4 in these applications of the machine is missing [2, 3].

At the bottom of the base 26 the device for transferring mechanical energy is mounted 30. To carry and install in the working position 19 there are two main and four auxiliary 12, 13 handles. They are compact, have a sufficient mechanical strength with minimum weight, allow operators during pile driving not only to hold the machine with hands, but also to stand (or sit) on them.

In the electromagnetic machine mounted version for the study of the geological section to a depth of 500 m sensors, carrying handles and transmission devices mechanical energy are excluded. The source generates a pulsed impact energy A_y= 600 – 750 Joules with a switching frequency of n_y=0.1 – 0.2 c^{-1} and is equipped with a power supply system with the intermediate capacitive storage device of capacitance Farad'n to reduce the load on the supply battery [10, 13]

3. Conclusion

Systems with electromagnetic machines for processes with a linear trajectory of labor movements are easier in work, have 2-3 times less of the functional units and stages in the energy conversion than conventional systems do and provide energy savings.

Electromagnetic strike machine with output energy of 0.4 – 0.8 kJ for dynamic sensing of soils and land seismic pulse low water depths provides ecological compatibility, safety and high quality of operations.

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