The System of Clamping the Base Plate of the Seismic Vibrations Sources to the Ground

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***Abstract* — There are various mechanisms for seismic surveying of the Earth, the excited oscillations or pulses. Design engineers constantly search for methods to create the lowest weight mechanim, which could be used in as many geographical zones as possible including areas difficult to travel through for heavy vehicles. The article reviews the systems of clamping the base plate to the ground.**

Keywords — sources of seismic vibrations, systems of clamping the base plate to the ground

I. INTRODUCTION

There were analyzed various types of seismic sources in [1–3] works. Special attention was paid to the seismic vibrations sources vibrator, in particular their operating mechanisms. Another key component, defining the technological capabilities of the seismic vibrations sources is the system of clamping the base plate to the ground.

II. THE SYSTEM OF CLAMPING THE BASE PLATE

Nowadays among all known methods of clamping the gravity methods are widely used due to their technical simplicity. In gravity methods of clamping the clamp is carried out by the own weight of the operating mechanisms (Fig. 1, 2) or additional tightening weight as in the case of electromechanical vibromodules. In this case significant limitation of the maximum power (generated force) is typical for seismic sources to ensure continuous contact of the vibrating source with the ground at developing on the surface the dynamic forces P_{din} the gravity clamp with the inertial mass M_{in} [4] is required:

$$M_{in} \cdot g > P_{din}. \quad (1)$$

Thus, to increase the power of vibration exciter it is required to increase of inertial masses, which complicates the mobility of the whole seismic source, limiting its use in difficult access areas.

A weight of vehicle on which a vibration exciter is mounted for transportation can be used as a tightening weight. All domestic and foreign sources of seismic vibrations are designed the same way. But the creation of mobile vibrating devices of high power (with a force of 20-30 m and above) is associated with a vehicle of the same capacity.

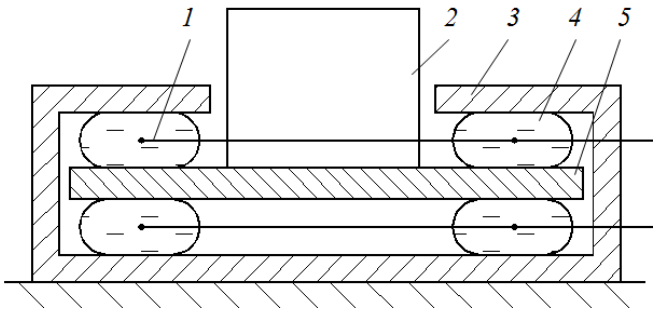

Fig. 1. The chart of mechanism clamping by its own weight:
1, *4* – elastic shells; 2 – load (inertial mass); 3 – base plate; *5* – plate

In this case, there is a problem connected to the limited carrying capacity of modern vehicles and the requirements to good cross-country capacity of seismic sources in off-road conditions, complex terrain, wetlands. But recently introduced new environmental requirements significantly reduce this limit. For example, the model of all-terrain rubber crawler type vehicle with the ground pressure of 14 kN/m^2 MST-2000 the Japanese company «MOROOKA» has the maximum mass in running order not exceeding 10 tonnes. Russian-Canadian all-terrain vehicle «Yamal» at a pressure of 35 kN/m^2 has a large weight, energy costs (engine power 710 hp) and complicated to operate.

Recently, seismic sources, manufactured by «Mertz» and «Pracla-seismos», mounted on 2, 3 or 4-axle heavy vehicles with one or two diesel engines up to 500 hp and exciting effort to 16-27 tons are used. The total weight of the machine reaches 16-27 tons.

Russian analogues of seismic vibrators SV5-150 and SV10-100 develop amplitude of strength of 5 and 10 t in the frequency range Hz 5÷100 have weight, reaching 20 tons [5].

Thus, one of the main drawbacks of modern seismic vibration sources which limit their geographical implication for the field works is the heavy weight of a clamp system.

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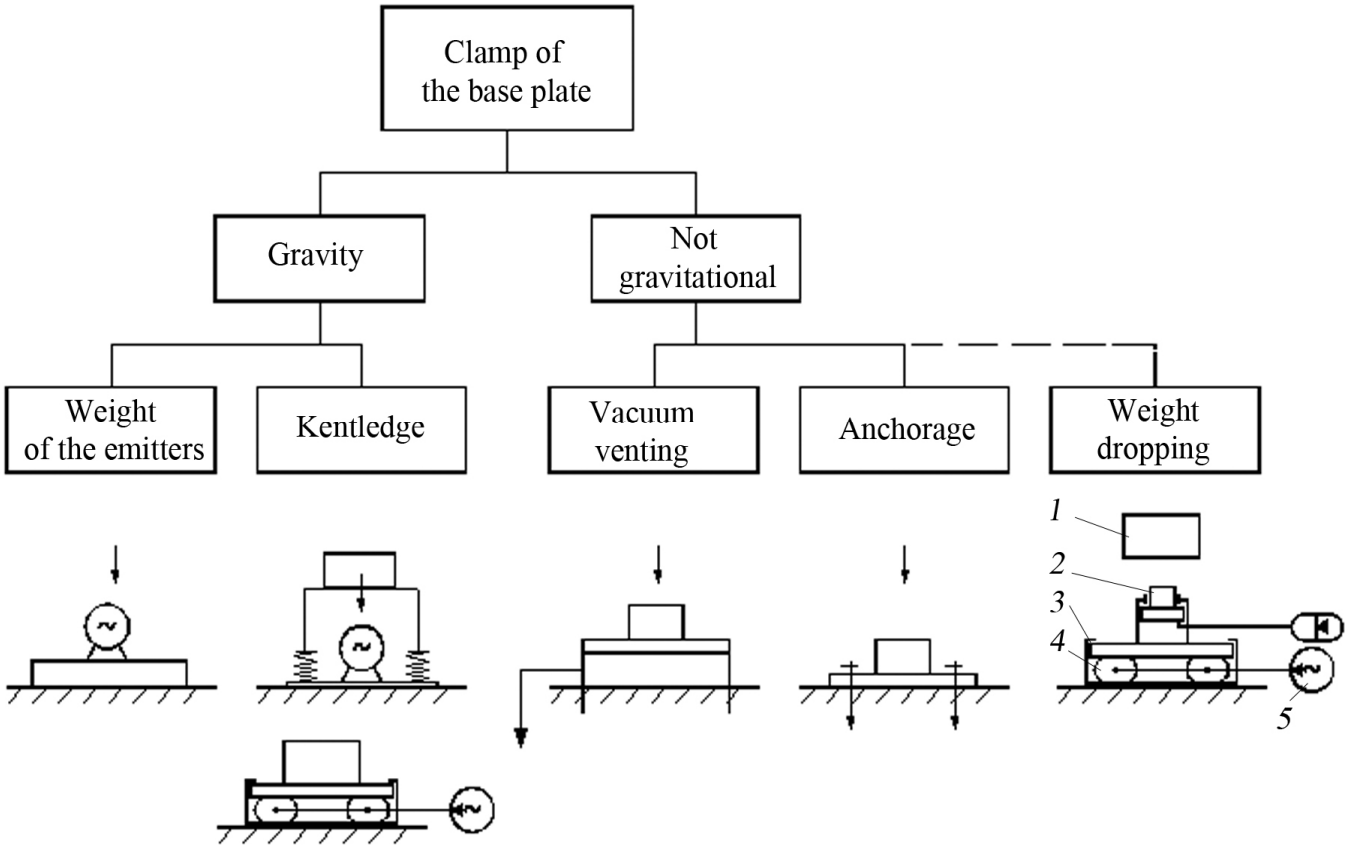

Fig 2. System of clamping the base plate of the seismic vibrations sources to the ground
1 – load; *2* – shock reducer; *3* – intermediate mass; *4* – elastic nonlinear shells; *5* – high frequency generator

Therefore the development of a high power vibrating source suitable for the specific region must be carried out taking into account the weight and size vehicle parameters and also the problem of clamping the base plate to the ground must be resolved.

This disadvantage can be avoided by replacing the inertial mass by the active periodically dropping weight.

Vibration and shock mechanisms used as sources of seismic vibrations according to the excited load are divided into the following types:

- pulse;
- vibrational;
- impulse-code.

Describing the benefits of a particular type of source one should take into account their specific features and applications.

However, the main criteria for assessing of seismic source benefits are the follows:

- high efficiency and stiffness of the dynamic characteristics;
- ability to create a large dynamic forces on the ground;
- relatively low weight;
- ability to carry out the accumulation of impacts;
- the fluctuations parameters regulation in the radiation process;
- ability to prioritize useful information in the background of the received interfering signals.

In this respect, the characteristics of vibration and impulse-code sources have significant advantages over regular impulse, especially for the vehicles of small and medium power. The increased capacity leads directly to an increase of weight and size. In this case preference is given to the exploration by pulsed sources. But this raises the problem of the accumulation of impacts and the impossibility of the exploration work near or directly in the settlements.

Exploitability of the device would be rather preferable if it's design would include the advantages of currently in use vehicles.

III. CONCLUSION

In the conclusion, a standard classification chart can be shown with a new tab related to a new class of vibromechanisms with an active dropping load (Fig. 3).

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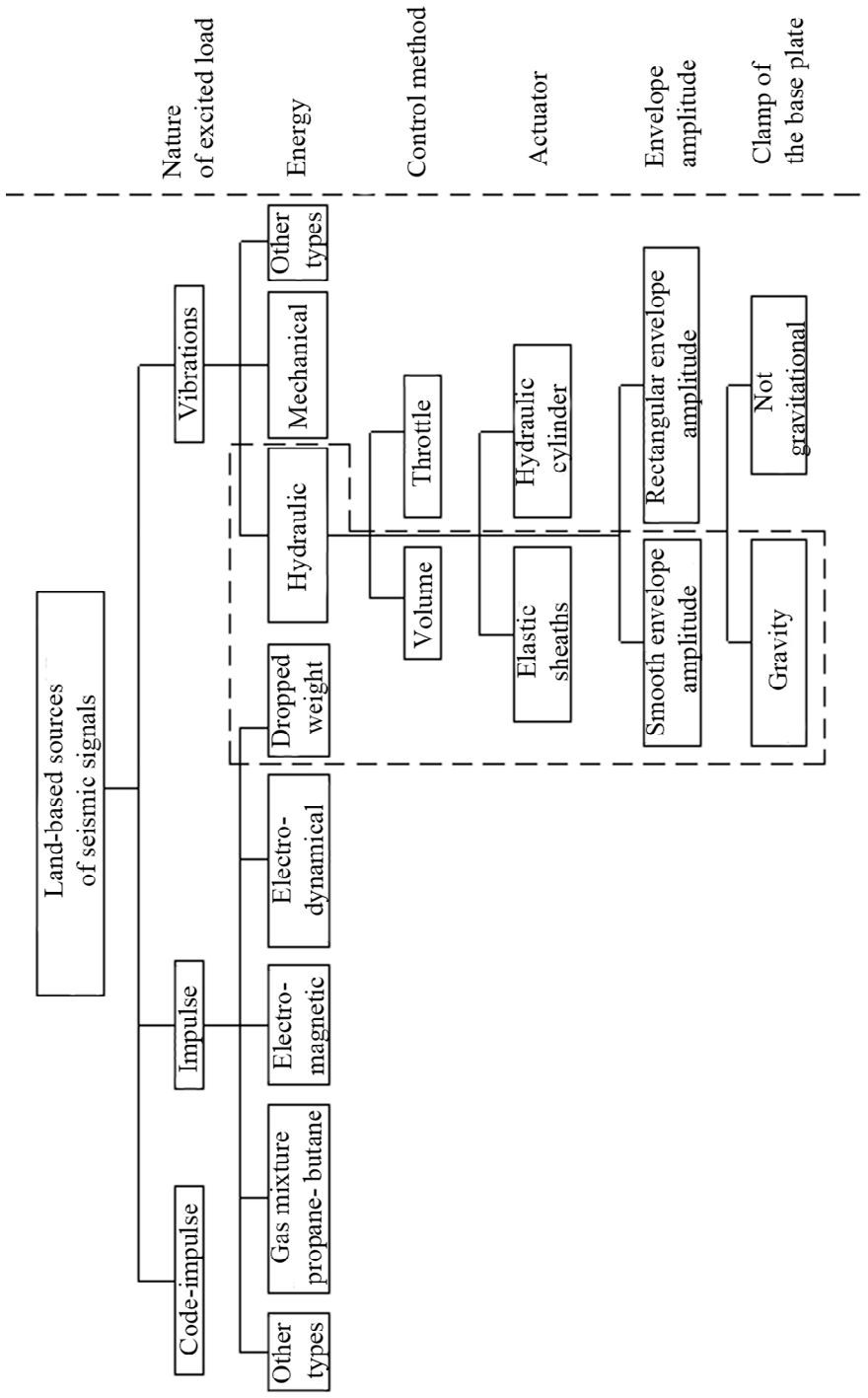

Fig. 3. Classification schedule of the seismic vibrations sources

Tomsk Polytechnic University has been granted a patent for a hydrostatic vibromehanizm [6–8] which includes periodically dropping active load *1* on the actuator, consisting of shock reducer *2* mounted on the intermediate mass *3*, the very intermediate mass on to preload elastic nonlinear shells *4* in which the sweep signal is excited by a high frequency generator *5* at the time of interaction of dropping load with the shock reducer (fig. 2).

Nonlinear stiffness characteristics of elastic shells through which the vibrational load formed is called the probing signal in seismology (to be discussed later). So the nonlinear stiffness is transferred to the ground allowing to create productive

dynamic forces which are comparable with the force of clamping the base plate to the ground.

The replacing of static inertial mass to the active load can significantly reduce the weight of the whole machine and to separate control by vibration parameters (dynamic force, frequency, amplitude) as well as to simplify the operating of the process of loads excitation.

Task for further work was formed from the analysis of seismic sources. It stipulates to conduct the research of the proposed scheme of hydrostatic vibromechanism and the ability of combined vibration load excitation with smooth envelope amplitude in the mathematical and physical models.

The specific research tasks are the follows:

- computer analysis of the impact of various forms of envelope amplitude of sweep signal force on the autocorrelation function properties under which draw a conclusion about the prospects of the use of the signal with different envelope form;
- research the new scheme of hydrostatic vibromechanism with active load, forming a combined signal with the smooth envelope having a low carrier frequency and informative sweep signal;
- study the effect of the accuracy of the envelope formation e on the properties of the autocorrelation function;
- study of the dynamic system of vibrating mechanism (a laboratory model of the seismic source) in which the impulse force simulates by an additional low-frequency mode generator in the main resonance mode;
- research of the nature of the effect of high frequency sweep signal to low frequency pulse (resonance frequency of the low frequency generator). To determine the boundary frequency on which the effect is minimal and based on this offer the beginning frequency of sweep signal. Find productive vibration modes at which the useful vibration load is comparable with the maximum value of the dynamic clamping force.

These issues will be discussed later.

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