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ANALYSIS OF THE OPTIONS OF MODERNIZATION OF ROLLER-BIT DRILLING MACHINES WITH A SUBMERSIBLE STEAMER

Dmitry A. YUNGMEISTER[1], Igor KRUPENSKI[2], Sergey A. LAVRENKO[1]
[1] *Saint-Petersburg Mining University, Saint-Petersburg, Russia*
[2] *Tallinn Technical University, Tallinn, Estonia*

The designs of submersible hammers and dampers protected by patents for reducing the vibration of the drilling rig of roller drill machines are proposed. The variants of modernizing drilling rigs for drilling hard rocks and faces of complex structures are considered. Particular attention is paid to the joint work of submersible shockers and pneumatic shock absorbers, the preferred schemes for the arrangement of these devices by drilling rigs are indicated. The results of experimental tests of machines with pneumatic hammers are presented to determine the vibration performance and drilling speeds. The pneumatic hammer allows increasing the speed of drilling process to the intensification of the destruction of the plain face by the shock load and the cleavage of the protrusions of the unevenness of the face, the better fitting of the bit to the face and the release of the blades or the bit pins from the drill bit. The choice of a particular type of damper or shock absorber depends on its design scheme and the possibility of changing the design of the drill string. With the complexity of installing a damping device in the mast (with significant dimensions of shock absorbers and drilling of strong heterogeneous rocks), it is advisable to use a set of tools to reduce hydraulic pulsations in the mains and cylinders of the hydraulic system by installing chokes in the oil plants and pneumatic shock absorbers. It is proposed to use the device for the development of pneumatic hammers by a patent-pending drilling method with a hollow piston filled with magnetically active heavy liquid, which will allow controlling the frequency and size of the shock pulses and partially compensating for the drill string fluctuations arising from the uneven immersion of the bit in the array . It is noted that the proposed solutions increase the drilling speed by an average of 15%.

Key words: drilling rig, submersible hammer, shock absorber, damper, shock system, drilling speed

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Introduction. So far the process of drilling blasting holes remains one of the main and most labor-intensive in the cycle of production in open pit mining. Abroad mobile drilling machines with submersible hammers (SMHs) and machines with hydraulic perforators are widely used, however, in the CIS mining enterprises the most popular are the roller-type drilling machines CBS-250.

The main advantage of domestic machines is the relatively low cost of drilling. The solution of the problem of intensification of drilling operations in quarries and sections where SBS-250 machines are used is the creation of new technical means to increase the productivity of drilling together with a reduced level of vibration of the drillstring and the preservation of the durability of roller bits.

To provide increased productivity of rotary drilling machines, magnetostrictive generators mounted above the chisel allow; cone bits of progressive designs and others; A significant change in the design of the basic machine is assumed.

The productivity of roller-bit drilling can be increased by applying a shock load to the bit by means of a percussion hammer (PH). At the same time, it is impossible to increase the productivity of drilling without decreasing the resource of the rock cutting tool without examining the vibration processes and choosing the rational operating modes of the drilling rig for given mountain conditions.

Application of the method and means of using submersible drums on rotary drilling rigs. The problem of intensification of drilling operations on the open development of the CIS countries can be solved by introducing into the production process modernized SBS-250 machines equipped with percussion hammers and pneumatic hydraulic shock absorbers between the first rod and the support block of the machine rotator, providing a lower cost of drilling wells than standard domestic and imported machines (Fig.1).

As shown in Fig.1, the following vibration reduction devices transmitted from the drillstring to the engine room can be applied to the SBS, increasing the drilling speed and increasing the durability of the bits:

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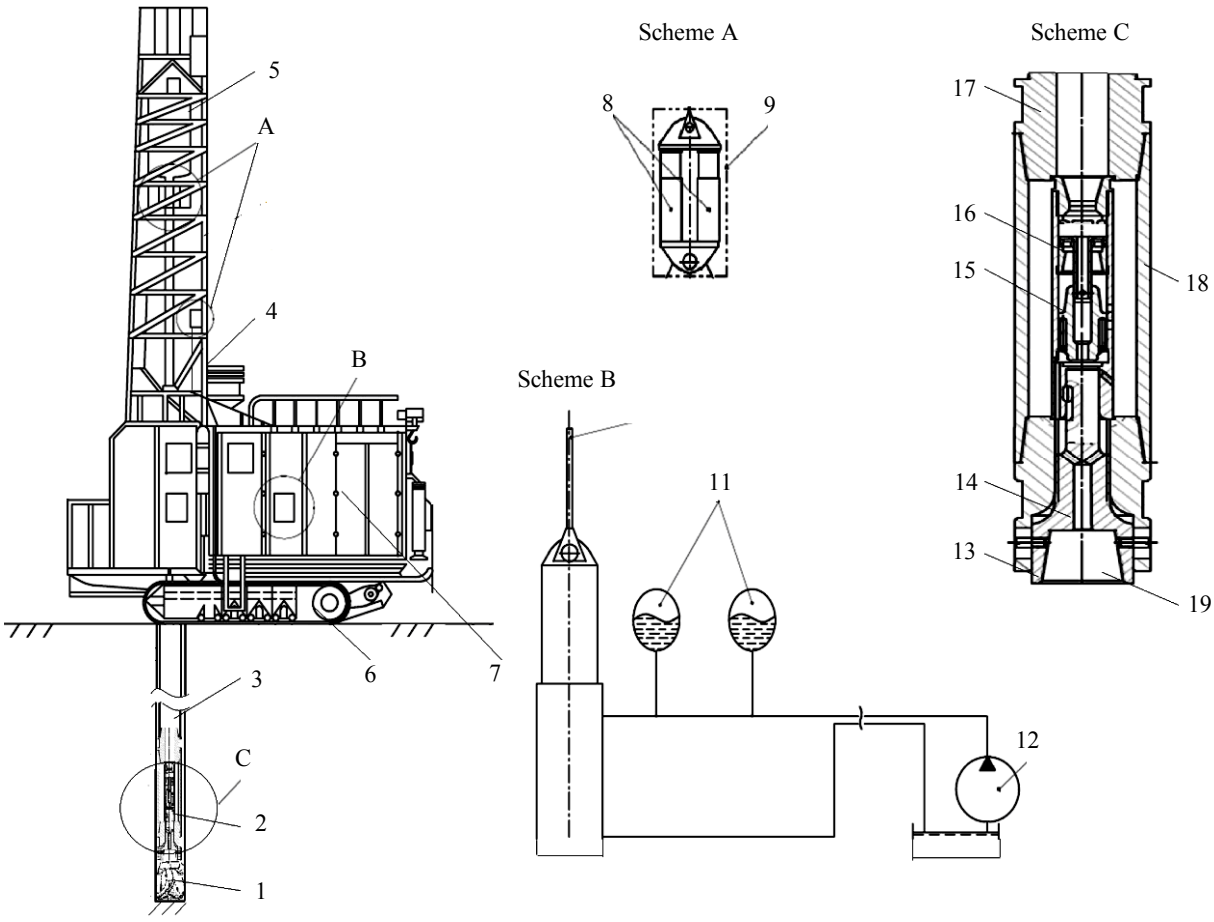

Fig.1. The scheme of the SBS-250 machine with a submersible hammer and additional means for reducing the vibration of the drilling rig

1 – cutter; 2 – air hammer; 3 – drilling rig; 4 – the mast; 5 – rotator; 6 – caterpillar drive; 7 – cabin; 8 – pneumohydraulic elements; 9 – damping unit; 10 – the feed line; 11 – pneumohydraulic accumulators; 12 – the hydraulic motor; 13 – the lower coupling; 14 – adapter; 15 – the piston of the submerged drummer; 16 – air distribution device; 17 – the upper coupling; 18 – body of a submersible drummer; 19 – location of the cutter assembly

1. The damping assembly (Scheme A) between the rotator and the drill rod or the damping assembly between the rope and the feed cylinder. The disadvantage of the method of installing the damper in the drilling assembly is the necessity of shortening the rods, the manufacture of a block of pneumatic shock absorbers with sliding connection of parts with a constant transfer of torque; adjustment of the shock absorber for drilling rocks of various strengths and fractures; The disadvantage of installing a damper in the hydraulic cylinder is the difficulty in locating the damper in the mast.

2. Installation of pneumatic accumulators (Scheme B) on the discharge line of the supply cylinder [2, 3, 7, 10-12]. This method has the following drawbacks: the complexity of the set of components, the need to change the design of the standard oil plant, the increased complexity of the work, the need to reconcile the design of the oil station with the North-West Federal District of Russian Federal Supervision Agency for Information Technologies and Communication.

3. Installation of the submersible hammer (Scheme C), it being understood that the SMH operates with one of the damper options or a different type of shock absorber is installed [5]. Disadvantages – the complexity of adjusting the frequency of impacts and other parameters of the hammer to select a mode of operation that could reduce the level of vibration of the drillstring; R & D is required.

Investigation of the parameters and design of machine tools SBS with SMH. The analysis of the above schemes shows that for the open work conditions the design of the submersible polyurethane foam and the damper according to scheme A (Fig.1) is most applicable, which can be most easily realized by the quarry's mechanical service. For example, NIPIgormash together with other organizations in the late 80s of the XX century. A series of pneumatic hammers of the original de-

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sign for drilling wells with a diameter of 105-200 mm was created. Abroad, submersible hammers are produced in Sweden, USA, France, Germany, Canada, Japan, Great Britain, Belgium. In the USA, hammers are produced by Ingersoll Rand, Gardner Denver, Mission, Joy, and others [4]. The company «Ingersoll Rand» produces a series of hammers for drilling wells with a diameter of 85-762 mm, the SMH of this firm have a similar design. They are designed for compressed air pressure in the network of 0.703; 0.815 and 1.76 MPa. These SMHs assume the use of special crowns.

In 2002-2010 under conditions of JSC «Apatit» measurements of vibration parameters SBS were conducted to align with the experimental values acceptable health and safety standards, and carry out research work SBS DTH (for the base – adopted SMH Kyshtym machine manufacture) is number to determine the effect of bit wear on the change in vibration parameters. The vibration parameters were measured using the SVAN946 measuring equipment.

Analysis of the vibration measurement graphs on the SBS-250 (board number 18) showed that for low frequencies, vibration acceleration exceeds sanitary standards. This is unacceptable for the normal operation of machines, so the use of tools that reduce the level of vibration.

As research by E.A.Zagrivniy, B.N.Kutuzova et al. [1, 4] applying pneumo-hydraulic shock absorber according to the scheme A (Fig.1) to reduce the floor vibration parameters of the engine room and the driver's working space (vibration amplitude , and partly the frequency of oscillation) 3-5 times, improves the change in productivity by at least 15 %, up to 70 m/cm and more.

Analysis of the experimental curves speed drilling machine SBS MNA-250-32 with and without the NPU from the bit rotational speed at different values of the axial load F (Fig.2) [8] indicates that the penetration rate has a power dependence of the axial load. In the above range the axial load and the rotational frequency of the bit provided passport drilling operations, both at the base of the machine and when working with the machine NHRI critical axial load is observed. Analysis drilling speed depending on the frequency NPU punches showed that growth SBS MNA-250 32-well drilling machine speed when using the NPU to intensify the process of drilling at P = 0.2 MN, bit rotation frequency of 2 rps and frequency of 12 s^{-1} is 13 %.

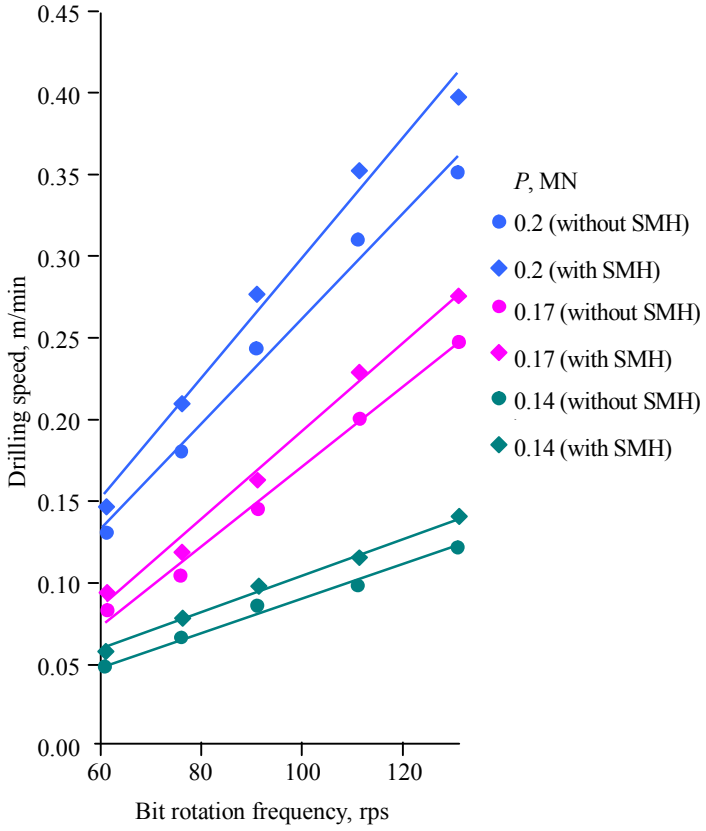

Fig.2. Drilling speed versus chisel rotary velocity

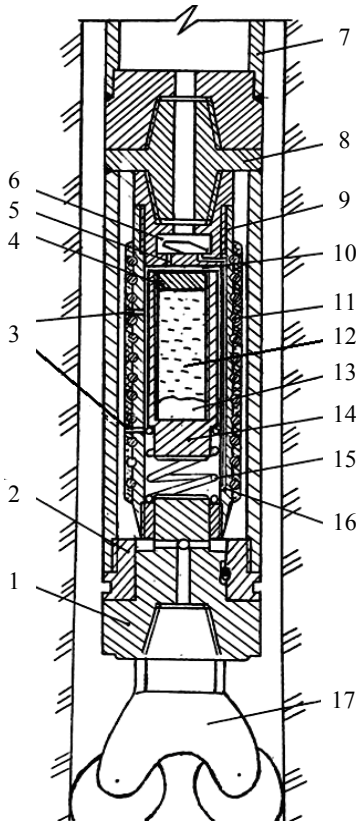

Fig.3. SMH with hollow drummer

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To intensify the drilling process of the SBS-250 machine, it is also possible to use a drill roller cutter (Kyshtymsky Machine Building Plant, SBSU-250, see Fig.1, Scheme C) or upgraded samples of such a projectile, for example, a SMH intended for a combined drilling method explosive wells, in which the spring-loaded piston-hammer is used to reduce the harmful effects of the SMH on the rotator and the machine as a whole. To protect the cutter from the harmful impact of impact loading, the polyurethane foam must be upgraded, for example using a hollow piston drilling method [6]. With this method, an additional impulse is imposed on the main impact pulse transmitted to the rock from the hammer body by moving a heavy magnetically active liquid filled with a hollow piston (Fig.3).

Analysis of the results. On the basis of the research conducted by the SMH for SBS, it is recommended to use them together with a pneumatic-hydraulic shock absorber (Fig.1, Scheme A), and constructive decisions should be made in accordance with previously performed work [5, 6]. The action of the additional shock absorber essentially reduces the first natural frequency and puts the system into the pre-resonance mode. Resonance values are small, especially for the second and subsequent resonances, which are explained by the sufficiently large viscous damper resistance. Improvement of the SMH implies regulation of the frequency of impacts [6], which is the least researched and, in our opinion, a promising area for improving PPU. In this case, the structure of the impactor with an adjustable frequency of impacts and the frequency of impacts are chosen so that the longitudinal oscillations in the stove from bit impacts to the rock are reduced. In our opinion, in this case, three-mass systems can be used, in which the striking of the striker is realized [5, 8, 9].

Technical modernization of the polyurethane foam according to the patent [6] should be carried out due to the impact, divided in time, and the possibility of adjusting the impact pulse. In Fig.3, the rock cutting tool 17 mounted on the drillstring 7 comprises hammer 10 with an elastic element (for example, a spring 15 in the body 9) made with built-in electromagnetic windings 11 for generating electromagnetic oscillations. The piston 14 of the impact mechanism 10 is made hollow with a filling of a heavy magnetically active liquid with a low viscosity of 12 (for example, a liquid filled with metal particles). The air distribution mechanism 6 with the channels 16, 5 and 3 causes the piston 14 to reciprocate in the body 9, which is connected on one side by the end clutch 1, the adapter 2 with the tool 17, and on the other side by the adapter 8 with the valve 7. The piston 14 has chambers 13 separated by partitions 4. The change in the front shape of the shock pulse, necessary for the destruction of rocks of different strength, composition and fracturing, is produced by creating an additional pulse obtained by moving a heavy magnetoactive liquid with a low viscosity. The creation of a rational pulse shape for a particular rock, depending on the type of rock cutting tool and drillstring, increases the durability of the crowns, and also increases the drilling speed [6].

Conclusion. An analysis of the possibilities for improving the drilling tools for blast holes and large diameter boreholes shows that the preferred and simplest approach, among others, when creating a shock impulse of a given type for a SBS is a method of combining impact and rotary (cone drill) drilling. Further research is needed to study the effect on drilling efficiency of the following factors: damping parameters, different types of impactors (including hydraulic), design and configuration of drums (twin, with cavities and special filler).

The working capacity of the developed design of the SMH has been experimentally confirmed and it is proved that the use of the SMH does not lead to an increase in the maximum amplitudes of the longitudinal oscillations of the drilling rig of the SBS rig.

It has been experimentally proven that the use of PPU to intensify the drilling process of the SBS-250 MNA-32 machine is to increase the drilling by an average of 15% and the bit strength up to 10%. Air hammers, working together with dampers, can be recommended to factories for the modernization of quarry machines.

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***Authors*: Dmitry A. Yungmeyster,** *Doctor of Engineering Sciences*, *Professor*, *iungmeister@yandex.ru* (*Saint-Petersburg Mining University*, *Saint-Petersburg*, *Russia*), **Igor Krupenski,** *Candidate of Engineering Sciences*, *Researcher*, *igor.krupenski@ttu.ee* (*Tallinn Technical University, Tallinn, Estonia*), **Sergey A.Lavrenko**, *Candidate of Engineering Sciences*, *Associate Professor*, *Lavrenko_SA@pers.spmi.ru* (*Saint-Petersburg Mining University*, *Saint-Petersburg*, *Russia*).

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