

## NON-DESTRUCTIVE CONTROL OF THE BASIC SHAFTS OF MINE HOIST MACHINES

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**ABSTRACT.** The technology for non-destructive control of the basic shafts of mine hoist machines is based on ultrasounds and magnetic-dust defectoscopy. The article considers the application of the two methods for control in the various critical cross-sections of the shafts. Determined is the position of the controllable sectors and ADD are applied – diagrams for adjustment of the control sensitivity and evaluation of the defect dimensions.

### БЕЗРАЗРУШИТЕЛЕН КОНТРОЛ НА ОСНОВНИТЕ ВАЛОВЕ НА РУДНИЧНИТЕ ПОДЕМНИ МАШИНИ

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**РЕЗЮМЕ.** Технологиата за безразрушителен контрол на основните валове на рудничните подемни машини, се базира на ултразвукова и магнитно-прахова дефектоскопия. В статията се разглежда приложението на двата метода за контрол в различните критични сечения на валовете. Определено е разположението на контролируемите участъци и са приложени АД – диаграми за настройка на чувствителността на контрола и оценка на размерите на дефекта.

### Introduction

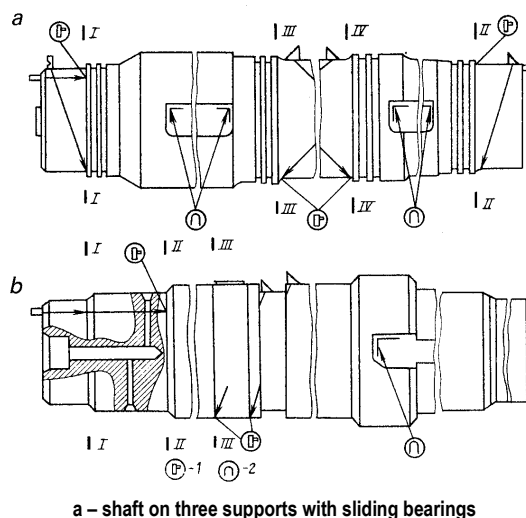
Hoist machines are the main element of mine hoist systems. Complete with the other elements of the mine hoist system – hoist vessels, hoist and balance cables, guide pulleys, shaft frames, etc., they have a primary function and are subject to periodic control for the purpose of guaranteeing operation safety.

The basic shaft of the mine hoist machine (MHM) receives the entire external load and transmits it through the bearings of the foundation. In the process of exploitation of the basic shafts sudden loads emerge upon bedding of the emergency brake, overloading of the hoist vessels or their abrupt lowering, etc. Particularly dangerous are emergency loads due to overhoist and bumps of vessels deviating from the reinforcement and buntions of the shaft.

### Defectoscopy methods

The technology for control envisages ultrasound and magnetic-dust methods for defectoscopy. The ultrasound method is used for control of the roundings of the shaft shoulders and the places of press fits (mainly for pipe shafts). The magnetic-dust method is used for control of the exits of the key channels of stressed connections, around the lubricant-feed openings, and when necessary – for specification of the parameters of defects found by ultra-sound methods, with ensured access to the controllable surface.

Defectoscopy is recommended to be conducted during capital repair of the hoist machine and upon expiry of the service life indicated by the manufacturer, and also upon violation of the exploitation rules when the shaft has been damaged because of incongruous load. Defectoscopy is applied to the main shafts of the MHM with drum diameter from 1.2 to 9 m.

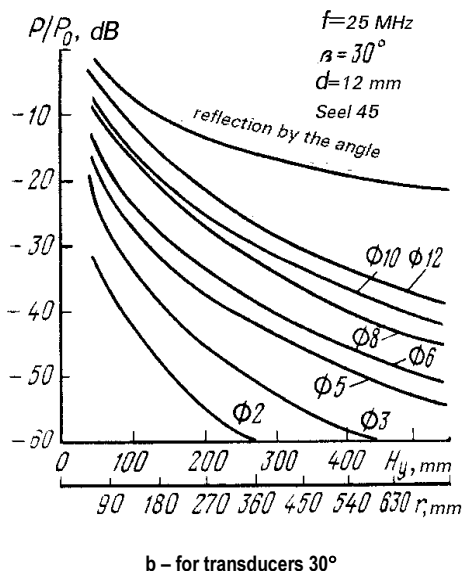
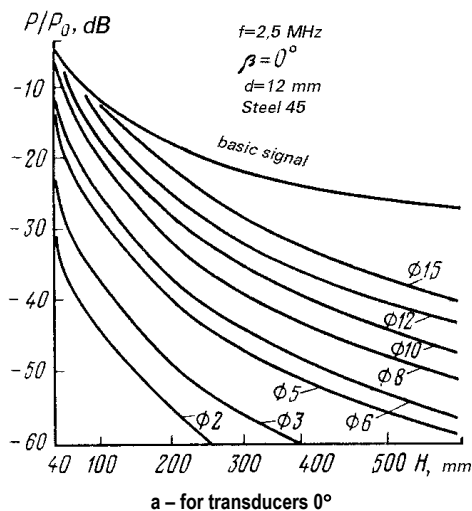


a – shaft on three supports with sliding bearings  
b – shaft on two supports with roll bearings  
**Fig.1 – Disposition of the controllable sectors of the basic shafts of the MHM**

Fissures from material fatigue usually appear in the roundings, the places with press fits, key connections and

lubrication openings. Fig.1 shows the position of these sectors on the basic shafts of the MHM. To discover the fissures, preventive defectoscopy of the shafts is carried out.

Ultra-sound control (1-fig.1) uses type transducers at the frequency of 2.5 MHz with entry angles of  $0^\circ$ ,  $41^\circ$ ,  $50^\circ$ , as well as separately-combined used depending on the possibilities for access to the various control zones, the type and dimensions of the shaft. Control sensitivity depends on the remoteness of the controllable zone from the point of entry of the ultra-sound oscillations and has to provide for discovery of artificial defects with surface area: up to 100 mm – 7 mm<sup>2</sup> (3 mm), from 100 up to 400 mm – 50 mm<sup>2</sup> (8 mm), from 400 up to 700 mm – 80 mm<sup>2</sup> (10 mm), above 700 – 700 mm<sup>2</sup> (30 mm).



The sensitivity of the magnetic-dust control method (2-Fig.1) must correspond to the conditional level of sensitivity B. Sensitivity is adjusted by a reference-free method, by reading ADD (amplitude, distance, diameter) diagrams. The use of ADD – diagrams for control sensitivity adjustment and evaluation of defect dimensions – excludes errors from possible differences in the acoustic characteristics of the material of the sample and the article. Normally, in order to obtain the support curve of the main signal, a support echo-signal from the cylindric surface of the shaft itself is used,

obtained in several points situated along the various shaft diameters. Such solution is possible for distances from the point of signal entry to the reflecting surface longer than 80 mm and therefore it is acceptable for control of the basic shafts (the minimal distance from the point of entry of the ultra-sound oscillation to the controllable zone is equal to 90 mm). Fig.2 shows ADD – diagrams used for the adjustment of control sensitivity with different transducers.

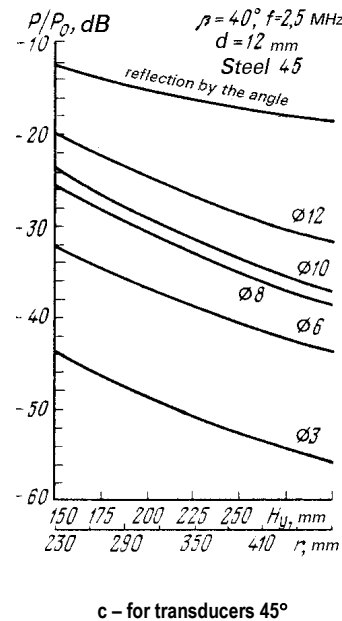


Fig.2 – ADD – diagrams for adjustment of the sensitivity and evaluation of the equivalent dimensions of the defects

In the ultra-sound control of the roundings of shafts with roll bearings the transducers are mounted perpendicularly to the front surfaces of the separate shoulders, and for shafts with sliding bearings (except for the middle necks of the shafts of three supports), mounting can also be done obliquely to the front surface with directionality along the generatrix of the shaft neck. Control of the step-like parts of the shaft and the places of press fits (for pipe shafts) is carried out with transducers inclined to the shaft surface and directed along the generatrix. Upon discovering a defect, we have to determine its coordinates, equivalent surface and conditional remoteness. The magnetic-dust control is carried out as per the scheme shown (Fig.1) with a SON, as the shafts as a rule are made of steel 45. For magnetization, there are used electric contacts and flexible cable from the apparatus set. For determination of the direction of the magnetic force-lines of the magnetic field and evaluation of the control sensitivity, special accessories are used (Fig.3), the main element whereof – control sample 2, is a steel disk consisting of seven segments, tightly fitted one to another and soldered. From the reverse side of one of the segments a 3mm groove is made by means of a chisel, for evaluation of the control sensitivity, so that on the uppermost surface of the disk a clear groove is formed. After that, the upper surface of the disk is ground until a smooth surface with a visible trace is formed in the cutting spot and is covered with several layers of light nitro-enamel. The sample is placed in frame 1 of non-magnetic material, which has openings to pour suspension. Frame 1 is fixed in a wire frame 3, which can rotate by use of tubular handle 4. The controlled sectors of the bearing necks of the shaft are de-magnetized.

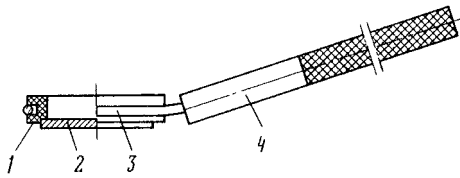


Fig. 3. Accessory for determination of the direction of the magnetizing field and the control sensitivity

## Conclusions

The application of preventive defectoscopy of the basic shafts of the mine hoist machines helps to prolong the service life of the whole hoist system, and also increases the reliability of its exploitation. In the cases of emergency load or low quality of repair or mounting, a defectoscopy of the shaft will enable us to predict the safety in the exploitation of the hoist system.

Recommended for publication by Department of  
Machine Science, Faculty of Mining Electromechanics

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