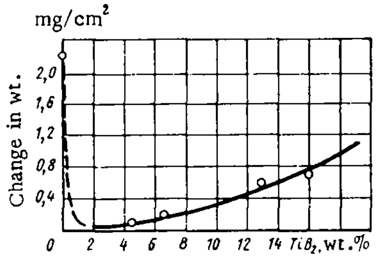

Fig. 4. Scale resistance of 12Kh18N9T$-$TiB$_2$ alloys.

alloys were weighed before and after annealing at 550° for 100 h. As follows from Fig. 4, small additions of titanium diboride [in solid solution, according to the phase diagram (see Fig. 1)] sharply increase the scale resistance of the alloys, in agreement with the literature data [4]. As the concentration of titanium diboride in the alloy is increased it precipitates in the form of eutectic colonies, which leads to an increase in the length of interphase boundaries and lowers the scale resistance. Eutectic alloy 12Kh18N9T$-$TiB$_2$ (13 wt. % TiB$_2$) has a lower scale resistance than the alloy with 1-2 wt. % TiB$_2$, although it is three times higher than that of cast steel 12Kh18N9T.

Thus, eutectic alloys Fe$-$TiB$_2$ and 12Kh18N9T$-$TiB$_2$ in the cast condition have a high strength at room and elevated temperatures (up to 1000°) and high wear resistance under dry friction conditions.

Eutectic alloy 12Kh18N9T$-$TiB$_2$ has relatively high corrosion resistance and good scale resistance at temperatures up to 550°.

Machine parts can be manufactured from these alloys by means of casting.

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EFFECT OF ELECTROLYTIC COATINGS ON ACOUSTIC RADIATION OF HIGH-STRENGTH CAST IRONS

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UDC 621.8.034.4:669.13

One method of preventing noise and vibration is to extinguish harmful vibrations by means of the high vibration-absorbing capacity of the material and coatings on the material. In most cases this is the most economical method, and in some cases the only possible method [1].

This work concerns the effect of single-layer and multilayer electrolytic coatings on acoustic radiation, i.e., the level of acoustic pressure, the damping time, and the damping coefficient of acoustic vibrations of high-strength cast irons. The method of investigation and the recording devices were described in [2].

High-strength cast irons with ferrite–pearlite and pearlite structures were used. High-strength cast iron combines several valuable properties of steel and ordinary gray cast iron, and thus is useful as a special structural material. However, high-strength cast iron does not have the high damping capacity characteristic of gray cast iron. To improve this property it is necessary to reduce the acoustic radiation of high-strength cast iron to that of gray cast iron.

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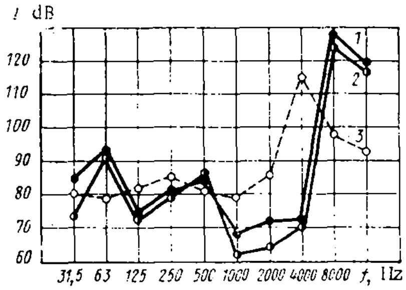

Fig. 1

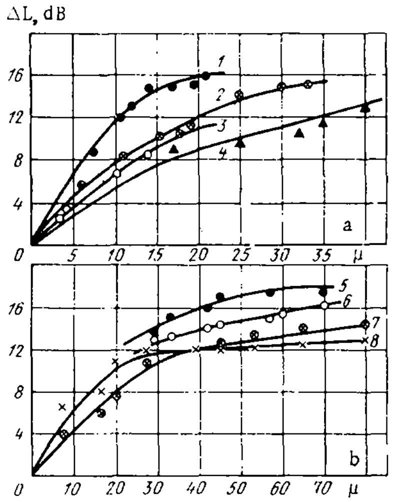

Fig. 2

Fig. 1. Distribution of acoustic energy by frequency ranges in high-strength cast iron struck with a ball. 1) Pearlite structure; 2) ferrite–pearlite structure; 3) ferrite structure.

Fig. 2. Effectiveness in reducing acoustic pressure (ΔL) of single-layer (a) and multilayer (b) electrolytic coatings on one side. 1) Copper; 2) chromium; 3) nickel; 4) zinc; 5) copper–zinc, both sides; 6) copper–zinc, one side; 7) copper–nickel, both sides; 8) copper–nickel, one side.

Preliminary studies of the distribution of the acoustic energy of an impact by frequencies in high-strength cast iron with ferrite–pearlite,pearlite, and ferrite structures showed (Fig. 1) that the total acoustic pressure is affected mainly by the high-frequency component of the spectrum, since the overall level in the low- and medium-frequency ranges differs from the high-frequency range by 40-50 dB.

In the high-frequency range the quantity of acoustic energy radiated is highest at frequencies of 8 and 16 kHz. Thus, the noise resulting from the collision of cast irons with spheroidal graphite is primarily high-frequency noise, which creates far worse working conditions than low- and medium-frequency noise.

Electrolytic coatings of copper, zinc, nickel, and chromium, which are most widely used in industry, were tested.

The electrolytic coatings were applied to the samples under conditions given in Table 1. The thickness of the coatings was determined by the jet–volume method (GOST 16875-71) at seven points along the diagonal of the sample.

Single-layer and multilayer electrolytic coatings reduce the radiation of acoustic energy to a certain level, above which the effectiveness of reducing the level of acoustic pressure is negligible (Table 2).

With increasing hardness of single-layer electrolytic coatings the range of their effect on the reduction of the acoustic pressure in the frequency spectrum broadens. Copper and zinc coatings reduce the acoustic pressure only in frequency bands of 18 and 8 kHz, and nickel coatings in frequency bands of 16, 8, 4, and 2 kHz. Chromium coatings, with high strength and large internal stresses, lower the acoustic pressure in frequency bands 16, 8, 4, and 2 kHz and 6.3 and 31.5 Hz.

A single-layer coating on one side with a thickness over 12-15 μ is the most effective, since the overall level of the acoustic pressure decreases by 12-14 dB. A copper coating on one side is the most economical, reducing the acoustic pressure 14 dB with a relatively small thickness of the coating – 11-13 μ.

Copper is also more effective in reducing the damping time, lowering the damping time by a factor of four with a thickness of 21 μ. Zinc coatings with a thickness of 40 μ have the same effect. Chromium coatings with a thickness of 19-25 μ reduce the damping time almost three times (from 0.17 to 0.25 sec).

The damping coefficient of acoustic vibrations increases sharply with the thickness of the coating and reaches values of 10.4-13.0, which is five times the damping coefficient of uncoated samples. The increase of the damping coefficient of acoustic vibrations reduces the duration of the noise.

TABLE 1

Coating	Component	Concn., g/liter	Current density, A/dm^2	Voltage, V	Temp., °C
Copper	Cuprous cyanide Sodium cyanide Caustic soda Sodium tartrate Ammonium thiocyanate Maganous sulfate	35–45 12–18 10–15 18–24 18–24 0,3	1–2	3,0	50–55
Zinc	Sodium cyanide Sodium hydroxide Zinc oxide Sodium sulfide	100–120 80–100 30–40 3–5	2–4	10–12	18–30
Nickel	Nickel sulfate sodium chloride Boric acid 1,4-Butynediol Monochloramine	250–350 10–15 30–40 1–2 2–4	2–3	4–6	50–55
Chromium	Chromium trioxide Sulfuric acid	250–300 2,5–3,0	30–35	12,0	45–50

TABLE 2

Type of coating		Name of coating	Thickness of coating, μ	Level of acoustic pressure, dB											Damping time of acoustic vibrations, sec	Damping coeff. of acoustic vibrations
				total	in freq. bands, Hz											
					31,5	63	125	250	500	1000	2000	4000	8000	16000		
Single-layer	On one side	Copper	11,9	$\frac{116}{129}$	$\frac{85}{70}$	$\frac{66}{91}$	$\frac{83}{77}$	$\frac{86}{79}$	$\frac{87}{86}$	$\frac{67}{62}$	$\frac{57}{54}$	$\frac{65}{69}$	$\frac{115}{126}$	$\frac{107}{120}$	$\frac{0,29}{0,95}$	$\frac{9,78}{1,86}$
		Zinc	17,0	$\frac{114}{127}$	$\frac{68}{72}$	$\frac{63}{89}$	$\frac{67}{75}$	$\frac{85}{78}$	$\frac{83}{86}$	$\frac{69}{70}$	$\frac{61}{58}$	$\frac{65}{58}$	$\frac{115}{125}$	$\frac{107}{118}$	$\frac{0,35}{0,85}$	$\frac{6,85}{2,05}$
		Nickel	20,5	$\frac{120}{130}$	$\frac{77}{81}$	$\frac{86}{92}$	$\frac{74}{74}$	$\frac{80}{80}$	$\frac{84}{84}$	$\frac{67}{68}$	$\frac{55}{72}$	$\frac{63}{71}$	$\frac{120}{127}$	$\frac{112}{120}$	$\frac{0,275}{0,95}$	$\frac{9,90}{1,86}$
		Chromium	19,0	$\frac{113}{125}$	$\frac{65}{91}$	$\frac{84}{91}$	$\frac{69}{73}$	$\frac{87}{79}$	$\frac{91}{86}$	$\frac{70}{62}$	$\frac{62}{64}$	$\frac{63}{70}$	$\frac{111}{124}$	$\frac{105}{117}$	$\frac{0,25}{0,71}$	$\frac{10,87}{3,97}$
Double-layer	On one side	Copper-zinc	29,0	$\frac{111}{127}$	$\frac{76}{73}$	$\frac{86}{89}$	$\frac{76}{76}$	$\frac{80}{77}$	$\frac{83}{87}$	$\frac{68}{71}$	$\frac{62}{58}$	$\frac{76}{69}$	$\frac{111}{124}$	$\frac{105}{119}$	$\frac{0,475}{0,85}$	$\frac{6,2}{2,05}$
		Copper-nickel	45,6	$\frac{118}{130}$	$\frac{83}{70}$	$\frac{98}{91}$	$\frac{83}{73}$	$\frac{86}{79}$	$\frac{97}{86}$	$\frac{74}{65}$	$\frac{69}{64}$	$\frac{64}{69}$	$\frac{116}{126}$	$\frac{110}{120}$	$\frac{0,22}{0,995}$	$\frac{4,5}{1,86}$
	On both sides	Copper-zinc	29,0	$\frac{109}{127}$	$\frac{75}{73}$	$\frac{88}{89}$	$\frac{75}{76}$	$\frac{81}{77}$	$\frac{84}{87}$	$\frac{69}{71}$	$\frac{61}{58}$	$\frac{77}{69}$	$\frac{108}{124}$	$\frac{104}{119}$	$\frac{0,30}{0,85}$	$\frac{8,0}{2,05}$
		Copper-nickel	27,3	$\frac{117}{129}$	$\frac{67}{70}$	$\frac{85}{91}$	$\frac{74}{73}$	$\frac{77}{74}$	$\frac{82}{80}$	$\frac{87}{62}$	$\frac{57}{54}$	$\frac{63}{69}$	$\frac{115}{126}$	$\frac{109}{120}$	$\frac{0,315}{0,95}$	$\frac{7,77}{1,86}$

Note. Numerators refer to coated samples, denominators to uncoated samples.

Two-layer copper–zinc coatings on one side and both sides are more effective than single-layer coatings on one side. With an overall coating thickness of 29 μ the acoustic pressure decreases 16-17 dB, amounting to 109-111 dB.

The substantial increase in the damping of acoustic vibrations of samples with electrolytic coatings is due to energy scattering in the electrolytic coating itself. Damping of acoustic vibrations is induced by the loss of the energy of vibration in the interlayer between the base metal and the coating and by the effect of "saturation" of the electrolytic coating with hydrogen, and also losses due to the nature of the electrolytic coating.

With application of two-layer and multilayer coatings the coating retains its primary ability (in the precathodic layer) to crystallize with high internal stresses. Therefore, the internal losses of Cu–Zn and Cu–Ni coatings on one side and two sides match the total internal losses in two-layer and multilayer coatings. Consequently, two-layer and multilayer coatings reduce acoustic radiation more effectively.

The reduction of the acoustic pressure (ΔL) in relation to the change in the loss factor of plates with an electrolytic coating can be determined from the formula

$$\Delta L = 10\lg\frac{\eta}{\eta'}K \text{ (dB)},$$

where η and η' are the loss factors of samples with and without coatings, respectively; K is a correction factor taking into account the thickness of the electrolytic coating.

Figure 2 shows the reduction of acoustic pressure in relation to the type and thickness of single-layer and multilayer electrolytic coatings.

CONCLUSIONS

Electrolytic coatings can be used as acoustic absorbers at temperatures up to 400°C. Reduction of the power of the radiated sound with simultaneous reduction of the radiation time substantially reduces the harmful effect of noise.

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EFFECT OF PROLONGED OXIDATION ON THE MECHANICAL PROPERTIES OF TITANIUM ALLOYS AT3 AND AT6

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Oxidation at 500-800°C increases the corrosion resistance of titanium and titanium alloys AT3 and AT6 in several corrosive substances [1-3].

We investigated the effect of prolonged annealing in air (25-500 h) at 600, 700, and 800° on the mechanical properties of alloys AT3 and AT6. Literature data refer only to VT1-0 [4] and alloys VT14, VT3-1, and VT8 oxidized at 800° for 0.5 h [5].

Samples were cut from extruded bars of alloys AT3 and AT6 as-received; the chemical composition is given in Table 1.

Samples 5 mm in diameter and 30 mm long were tested in the IM4R machine at a pull rate of 1.5 mm/min. The notch toughness was tested on standard samples in the KN-30 machine. Three samples were tested at room temperature for each point.

The samples were oxidized in the process of heating in air at 600, 700, and 800° for 25, 50, 100, 250, and 500 h (at each temperature).

Examination of the microstructure showed that in the original condition the alloys have a lamellar $\alpha + \beta$ structure, with coarser grains in AT3 than in AT6. The amount of β phase was small in both cases, but larger

TABLE 1

Alloy	Composition, %							
	Al	Fe	Cr	Si	C	O	N	H
AT3	2,7	0,20	0,28	0,24	0,02	0,16	0,03	0,005
AT6	5,1	0,28	0,33	0,29	0,03	0,08	0,02	0,007

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*Deceased.

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