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DOUBLE SEPARATING SCREEN ACTIVE CONTROL

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Abstract. In the paper it is studied the behavior of the control circuit for the force generating, the circuit being used in the case of active attenuation of vibrations of a screen of separation. It is analyzed the capacity of the control circuit to realize the force amplitude and phase, for certain imposed conditions, using filtered or non-filtered signal.
Keywords: control circuit, active control, active force.

1. Introduction

Considering that both screens vibrate like a rigid piston, the acoustic attenuation of the double screen of attenuation is [1], [2]

$$D = 10 lg \left\{ \frac{[\, \omega E(m_1 + m_2) + \omega d z_0^2 - \omega^3 m_1 m_2 d \,]^2}{4 z_0^2 E^2} + \frac{[\, 2E - \omega^2 d(m_1 + m_2)]^2}{4E^2} \right\}, \qquad (1)$$

where: ω - pulsation of sonorous waves; E – longitudinal modulus of elasticity of screen material; m_1, m_2 - masses of surface unit of two screens; d – thickness of air layer between screens; z_0 - air specific impedance.

From the Eq. 1, it results that the acoustic attenuation depends on the frequency of acoustic waves; it has the minimum value for the frequency

$$f_0 = \frac{z_0}{2\pi} \sqrt{\frac{m_1 + m_2}{m_1 m_2}} . \qquad (2)$$

From the Eq. 1, it also results that the acoustic attenuation of a double screen of separation depends on the cinematic state of the auxiliary screen, i.e. the screen, situated against the receiver. A modality of improvement of acoustic attenuation is to reduce the vibration amplitude of the auxiliary screen, in the field of resonance frequency. The attenuation of vibrations of the screen permits, at the same time, the active control of acoustic attenuation.

If the primary and auxiliary screen are independent, between the accelerations, velocities and displacements of two screens, considered as vibrating like rigid pistons, there are the relations

$$a_1 = a_2\left(1 - \frac{m_2\omega^2 d}{E} + j\frac{z_0 d\omega}{E}\right),$$

$$v_1 = v_2\left(1 - \frac{m_2\omega^2 d}{E} + j\frac{z_0 d\omega}{E}\right),$$

$$x_1 = x_2\left(1 - \frac{m_2\omega^2 d}{E} + j\frac{z_0 d\omega}{E}\right). \quad (3)$$

The decreasing of vibrations of the auxiliary screen can be realized by applying a force on the screen, which must impart to the screen a motion which has cinematic elements, opposite and equal as magnitude to the ones given by the Eq. 3. The force can be generated by a generator of force, for example, an electro-dynamic vibrator.

2. Force Control and Generating Circuit

The force control and generating circuit is presented in fig. 1, [3].

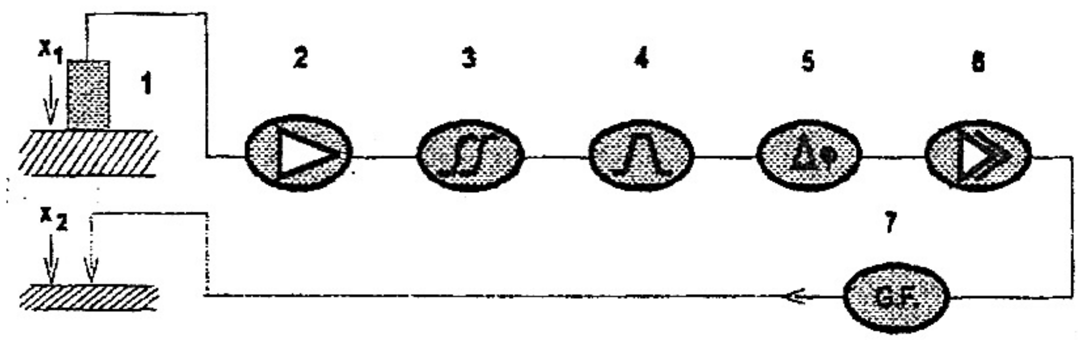

FIGURE 1. Force Control and Generating Circuit.

The notations in the figure are the following: 1 – accelerometer, 2 – preamplifier 3 – integrating circuit, 4 – band-pass filter, 5 – circuit of phase shift correction, 6 – power amplifier, 7 – force generator.

The study of theoretical behavior of the force control and generating circuit can be realized with the help of the circuit transfer function.

By adopting as control quantity of motion of the auxiliary screen the cinematic element "law of motion of primary screen", from the circuit transfer function, there are deduced for the ratio of amplitudes and phase shift of the circuit output quantity – the force F – and the circuit input quantity - x_1 - the law of motion of the primary screen, the expressions [3]:

$$\frac{F_0}{x_{10}} = \begin{cases} z^{\frac{k_0 k_1 k_2 k_3 k_4 R_2 Bl}{\omega^2 (1+a)\sqrt{R^2 + L^2\omega^2}}}, f < f_1, f > f_2, \\ z^{\frac{k_0 k_1 k_2 k_3 k_4 R_2 Bl}{\omega^2 \sqrt{R^2 + L^2\omega^2}}}, f_1 \le f \le f_2 \end{cases},$$

$$a = ln\{(2x^2 - 1) + [(2x^2 - 1)^2 - 1]^{0.5}\},$$

$$x = \frac{f_r(\frac{f}{f_r} - \frac{f_r}{f})}{f_2 - f_1},$$

$$\Phi_{(F, x_1)} = \begin{cases} -\pi + \Delta\varphi_{x_1} - \varphi, f < f_1, \\ -b + \Delta\varphi_{x_1} - \varphi, f_1 \le f \le f_r, \\ \Delta\varphi_{x_1} - \varphi, f = f_r, \\ b + \Delta\varphi_{x_1} - \varphi, f_r < f \le f_2, \\ \pi + \Delta\varphi_{x_1} - \varphi, f > f_2 \end{cases},$$

$$sin\Delta\varphi = \frac{R_1^2 X_C^2}{Z(R_1^2 + X_C^2)},$$

$$tg\varphi = \frac{\omega L}{R}. \tag{4}$$

The quantities which enter in the Eq. 4 have the significations as follows: k_0, k_1, k_2, k_3, k_4 - constants, introduced by the transfer functions of component elements in the control circuit; f_r - central frequency of band-pass filter; f – resonance frequency of auxiliary screen; φ - phase shift of force generator for the resonance frequency of auxiliary screen; x_{10} - amplitude of motion of primary screen; R_2 - load resistance of phase corrector circuit; B – magnetic inductance of force generator; l – length of winding of mobile coil of the electro-dynamic vibrator; L – inductance of mobile coil; R – resistance of mobile coil, Z – impedance of phase corrector circuit; φ - phase shift between the current which circulates in the mobile coil and the tension, applied to the force generator; $\frac{F_0}{x_{10}}$ – factor of amplification of control circuit; $\Delta\varphi$ - phase correction which must be realized for the resonance frequency of auxiliary screen.

From the Eq. 4, it results that the force *F* can be simultaneously realized for more frequencies, as amplitude and phase; it results that it is not possible the attenuation of motion of the auxiliary screen, simultaneously for more frequencies.

3. Conclusions

From the study concerning the active control of the coefficient of acoustic attenuation of a double screen of separation by the decreasing of vibrations of the auxiliary screen, it results the following conclusions:

- it is possible the improvement of acoustic attenuation by reducing the vibrations of the auxiliary screen, realized with the help of a force, applied to the auxiliary screen;
- the active force can not be realized as amplitude and phase, having certain values, simultaneously for more frequencies;
- because of the particularities of active force, it results that it is not possible the active control of motion of the auxiliary screen, simultaneously for more frequencies;
- for the attenuation of motion of the auxiliary screen, it is necessary the specification of the resonance frequency for which the vibrations of the screen will be attenuated, the acoustic attenuation having the most important increasing for the resonance frequency of the double screen of separation;
- in order to deduce the way in which the control circuit realizes or not the active force, necessary to the attenuation of motion of the auxiliary screen, it can be drawn the diagrams which represent the amplitude-frequency and phase-frequency characteristics of the control circuit, on the basis of Eq. 4.

References

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