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The analysis of influence of parameters of chain transfer on change of force of deformation of the elastic element of the compound conducted asterisk

Abstract: In article the technique of definition and calculations of deforming force and factor of rigidity of an elastic element of a compound conducted asterisk of chain transfer is resulted. Results of the analysis of the constructed graphic dependences of change deforming forces of the elastic plug of a conducted asterisk of chain transfer are resulted. Necessary parameters of system are proved.

Keywords: Chain transfer, asterisk, the elastic element, deforming force, rigidity factor, angular speed, weight, radius, tension roller, resource.

It is necessary to take into consideration the factor of deformation of flexible element when interconnection of gear with chain transmission. In figure-1 the impact of tension roller and scheme of bearing gear us shown. When chain 2 is co-worked with gear 1 the following forces are generated [1]: tension forces F_1 and F_2, chain 2 and trailing gear 1 generalized force Q_c. The system to be in balance:

$$\bar{F}_1 + \bar{F}_2 + \Delta\bar{F}_2 + \bar{F}_v + \bar{Q}_C = 0. \qquad (1)$$

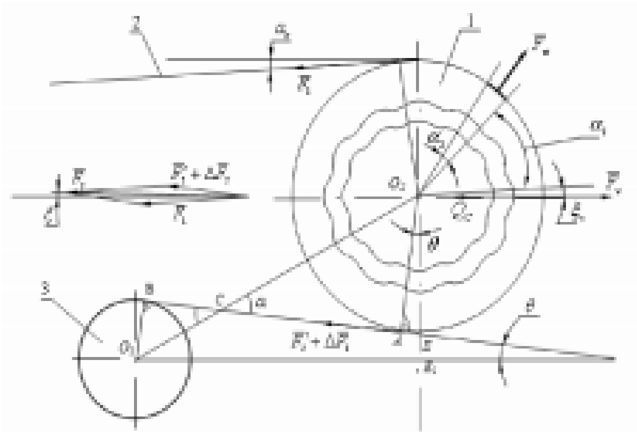


Fig. 1. Scheme of chain transmission trailing gear, where 1-component trailing gear, 2-chain, 3-tension roller

If we take tension forces of general horizontal axis organizer:

$$F_v \cos\xi = F_1 \cos\alpha_v - (F_2 + \Delta F_2)\cos\theta, \qquad (2)$$

where, ξ, α_v, θ - angles, generated by horizontal axis vectors.

If we define chain weight as q, tension force of AB length is calculated talking into consideration [1; 2]:

$$F_v = F_1 \frac{\cos\alpha_2}{\cos\xi} - \left[(r_2 + r_3)Ctg\left(\frac{\pi}{2} + \theta - \arccos\frac{O_2E_1}{O_2O_3}\right) + \Delta F_2\right]\cos\theta \quad (3).$$

In general chain connected with trailing gear, as per projection center escape affecting forces:

$$F_v = \frac{m_2\omega_2^2 r_2}{\cos\xi}\left[\begin{array}{l}\cos\left(\alpha_{21} + \frac{\alpha_2}{2}\right) + \cos\left(\alpha_{22} + \frac{\alpha}{2}\right) + \\ + \cos\left(\alpha_{23} + \frac{\alpha_2}{2}\right) + \ldots \cos\left(\alpha_{2i} + \frac{\alpha_2}{2}\right)\end{array}\right] \qquad (4)$$

In the condition shown above we will determine flexible element deformation force:

$$Q_v = -m_2\omega_2^2 r_2\left[\cos\left(\alpha_{21} + \frac{\alpha_2}{2}\right)\right] + \frac{F_1\cos\alpha_2}{\cos\xi_v} + \left[(r_2 + r_3)Ctg\left(\frac{\pi}{2} + \theta - \arccos\frac{O_2E_1}{O_2O_3} + \Delta F_2\right)\right]\frac{\cos\theta}{\cos\xi_v} \qquad (5)$$

Hardness coefficient of flexible element of trailing gear is determined by the following expression:

$$C_v = \frac{1}{\delta_x}\left\{\begin{array}{l} m_2\omega_2^2 r_2\left[\cos\left(\alpha_{21} + \frac{\alpha_2}{2}\right)\right] - \frac{F_1\cos\alpha_2}{\cos\xi_v} - \\ -\left[(r_2 + r_3)Ctg\left(\frac{\pi}{2} + \theta - \arccos\frac{O_2E_1}{O_2O_3} + \Delta F_2\right)\right]\frac{\cos\theta}{\cos\xi_v}\end{array}\right\} \qquad (6)$$

where, δ_x-is distance shift of gears of flexible element.

Thus it is recommended to determine distance between gear axis:

$$A = t_1 \cdot n_1 / \cos\alpha_r - \delta_{Ar} \qquad (7)$$

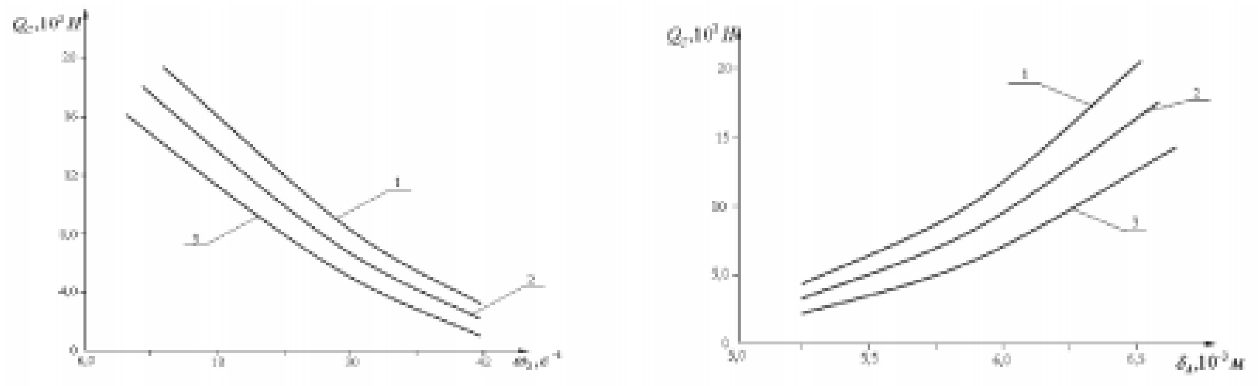
where, t_1 – is the step of between teeth of gean; n_1 – number of sections in the branch of trailing gear.

To get solutions as per expressions (5), (6), (7) the calculation parameters are taken in the following values:

$t_1 = 15.0 \div 21.0\ mm.$; $n_1 = 200 \div 400\ \min.^{-1}$; $[P] = 28 \div 31 MPa$;
$n_2 = 98,\ z_1 = 22, Z_2 = 25$; $r_2 = (5.5 \div 6.5) \cdot 10^{-2}\ m$;
$m_2 = 0.015 \div 0.035\ kg.$

In the fig. 2a the chain transmission trailing gear deformation force is shown in values generated in additional tension. The obtained diagram connections show that the increase of angle speed brings to nonlinear decrease. The tension belt working in transmission brings to increase Q_c force. When additional tension force increases from *60 H.* to *105 H.* and the difference between force is $\omega_2 = 18c^{-1}$ and when $4.15 \cdot 10^3 H$ is generated by it is generated pro ratio.

The main reason for it is the tension rolling influence in rotating frequency is not high, i.e. in this the momentum role is increased. It is necessary to state that the force which deforms flexible element by increasing radius of gear. We can see it the diagram already reviewed before. This law can be explained as follows. When the branches of chain the more its momentum force i.e. it decreases deformation force of flexible element. However, the long term operation of transmission is affected by deformation of flexible element. The deformation around axis of chain transmission with trailing element to be avoided from increase 2.0√3.0 mm when radius of gear is $r_2 = (5.5 \div 6.5) \cdot 10^{-2} m$ it is good select $(3.2 \div 5.4) \cdot 10^3\ N/m$. It is necessary to state that trailing gear shaft is working body connected with plug drum. Resistance fluctuation is decreased significantly at the expense of flexible element. I. e. vibration coming from clay brick to chain come with decreased force.



$1 - \Delta F_2 = 105N; 2 - \Delta F_2 = 80N; 3 - \Delta F_2 = 60N$ $\qquad$ $1 - m_2 = 0.015kg;\ 2 - m_2 = 0.025kg; 3 - m_2 = 0.036kg.$

Fig. 2. a – Diagram of chain transmission connected with angle speed; b – diagram bound with change of radius force and deformation of flexible element

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Research and application of acousto-optical tunable filters for modern telecommunications systems

Abstract: In article are considered integrated acousto-optical tunable filters, the analysis of possibility of adjustment of the surface acoustic wave is carried out and acousto optical conversion of modes on their basis, integration of optical technologies also is inspected.

Keywords: Acoustic waves, Electro-optical tunable filter (EOTF), Acusto-optic tunable filter (AOTF), Optical and Acoustic beam, interdigital transducer (IDT).

The idea of acousto-optical tunable filters (AOTF) was proposed in 1969 by Harris and Wallace [1] and was demonstrated by Harris and his colleagues. The flat (planar) integrated elements of acousto-optics, including filters, frequency switchers and modulators have been discussed in [2]. In this paper, the integrated AOTF are inspected according to them, the surface acoustic wave and acousto-optical mode conversion is analyzed as well as the integrated optical technology is considered.

The processes involved in the work AOTF are quite complex. The piezoelectric wave linked to a surface acoustic wave can produce secondary periodic electro interaction. This acoustic-electro optical interaction complicates the relatively simple batch representation induced birefringence, but a detailed source of effective acousto-optical interaction does not work at the primary frequency.

The development evolution of AOTF is presented in Table 1. The evolution progress was manifested in the movement from the volume of the optical wave and an acoustic wave to the volume of serial narrowing optical and acoustic rays to reduce the requirements for the power (energy) and to increase the interaction length.

Ohmashi and Noda used flat (planar) optical waveguides and surface acoustic wave in the first version of an integrated optical filter. The approach by Binh and his colleagues is limited to optical beam in single-mode optical waveguides and lowered power consumption by limiting the surface acoustic wave. Hink has been a pioneer in the use of patch installation laser for optical and acoustic waveguide. Goto developed the acousto-optic spatial mode converter, which had the same principle of phase comparison, as polarization mode converters, but this device is guided the filtered and unfiltered components to various waveguides [3].

Table 1. – Development evolution of AOTF

Date	Author	Development
1970	Harris	Volumetric Optical AOTF
1977	Ohmachi and Noda	Planar optical, IR filter
1980	Binkh and Livingston	The channel acousto-optical waveguide low power
1983	Goto	Spatial converter AOTF
1985	Khinkov	The technique of proton exchange
1988	Heffner	Frequency division for integrated optics
1989	Cheyung	The use of multi-frequency switching systems
1989	Smith	Highly integrated AOTF

AOTF can be performed based on various materials. Table 2 shows the characteristics of AOTF on the basis of a single crystal of quartz, Tantalus-lithium, and Niobe-lithium.

In the development of counter-doweled transducer (IDT) on the harmonics of the fundamental frequency, the response method is used piecewise approximation instead of synthesizing a smooth envelope of the impulse. This approximation is accurate enough when working on harmonics 3, 5, 7 in the synthesis of narrow-band (less than 2% for niobate LiNbO3 and Tantalus-lithium, less than 0.5% for the silica and zinc oxide films) filters with the most common designs suggesting GSW, transducers with capacitive weighing electrodes [4].

Table 2. – Technical characteristics of AOTF

Parameter	Units	The single-crystal quartz	Tantalate Lithium	Niobate-Lithium
Spectral range	nm.	750 … 850	1000 … 1150	1500 … 1700
The range of frequency control	MHz.	600 … 690	430 … 500	100 … 250
Input window	mm.	4×4	4×4	4×4
Input angular aperture	Deg.	2.8	3.4	2.2
Maximum driving power	W.	3	3	3
The diffraction efficiency	%/nm/W	20/800/1	15/1150/1	7/1550/1
Impedance	Om.	50	50	50

On the basis of the data in Table 2 it can be concluded that the most promising acousto-optical filters are AOTF based on niobate-lithium, which has the best technical parameters for use in fiber-optic data transmission systems (FDTS), and can improve the spectral characteristics of the emitted signal.

All integrated optical AOTF listed above should have some form of fiber, to be compatible with fiber optic communication networks, but one group bypassed the fiber compound, the problem by making a AOTF compatible with all types of fibers.

Narrowband mode conversion is achieved using a birefringent acousto-optic interaction medium. In this environment, the two polarization components — TE (horizontal) and TM (vertical) — and fall out of phase with the intrinsic beating length:

$$L_{beat} = \lambda/\Delta_{n'} \qquad (1)$$

where Δ_n — material birefringence; λ — emission wavelength.

If the applied DC voltage, the photoelastic effect produces a consistent TE — TM transformation and reverse transformation to a half wavelength, producing very little conversion for interaction lengths more L_{beat} — in fact, the resulting effective length of the element has a uniform voltage across its length and in most cases is $L_{beat}/2$, regardless of the length of material interaction. The only way to produce transformation events is to alternate the polarity of the voltage synchronously with the relative stage variable orthogonal polarizations.

The AOTF is achieved by moving the acoustic wave. The exact criteria for constructive interference or appropriate stage could be the fact that the wavelength of sound is equal to the length λ_{a} beats $\lambda_{a} = L_{beat}$. This leads to an equation relating the electrical frequency f_e and a favorite source of wavelength λ:

$$f_0 = (V_{sound}\ \Delta n_{eff})/\lambda, \qquad (2)$$

where V_{sound} — speed of sound, Δn_{eff} — the difference between the effective indicators.

An overall idea of a filter band width should be of constructive interference immunity test. The increment of wavelength is required to complete destructive interference, such that the first half of device interaction is in phase, while in the second half of device interaction is shifted in phase, leading to the complete quenching mode conversion.

This suggests the characteristic parameter band width of the filter:

$$\Delta = \lambda^2 / L\Delta_n. \qquad (3)$$

Fig. 1 shows a linear scale of the ideal transfer characteristic AOPF proportional to the square of the sinus.

If conversion is incomplete, the filter band width and sidelobe spectrum changes. The intensity (strength) of the side lobes in this case is relevant to the inter-channel interference for the operation of a multiple wavelength AOTF.

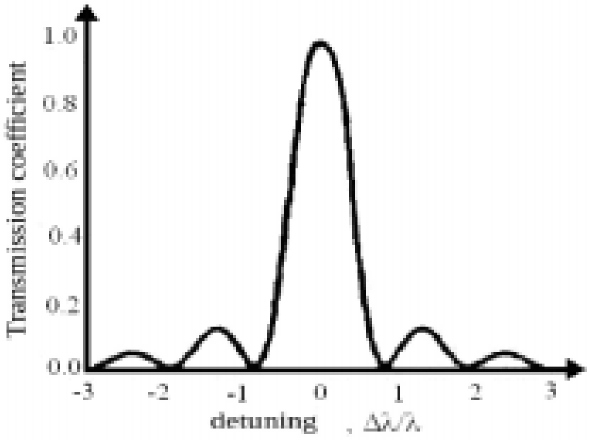

Fig. 1. Characteristic of ideal AOTF

The gain of the ideal AOTF as a normalized function of the wavelength can be represented as an analogue electro-optic tunable filter (EOTF) [5], because the physics of the two devices (elements) is very similar. AOTF and EOTF have the same optical transmission as a function of wavelength, but they differ in two important features. AOTF reached an appropriate stage through periodic electrodes and Δ_n is adjusted only slightly, leading to a modest adjustment range. The filter described in [6] only a tuning range was 15 nm., as offset adjustment — DC voltage. AOTF can filter only one band of the wavelength at a time, making it more versatile AOTF.

Therefore, for use in the AOTF in IDT it must have the ability to switch any number of channels (operating at different frequencies) simultaneously and independently of each other. The lightweight set-up and strengthening of the optical radiation of either is discussed in [7], [8] and [9].

To calculate the characteristic AOTF, the following relationship is used:

$$H(\omega)=\sum_{n=0}^{14}(-1)^n a_n \exp(-j\omega T_n)=a_n-a_n\exp(-j\omega T_n)+a_n-$$
$$-a_n\exp(j\omega 2T_n)+...+a_n-a_n\exp(-j\omega 14T_n)=1-\exp(-j\omega T/14+. \quad (4)$$
$$+\exp(-j\omega 2T/14)+...+\exp(-j\omega 14T/14)$$

This equation can be written as follows:

$$H(\omega)=\sum_{n=0}^{14}(-1)^n a_n\left[\cos\omega T_n-j\sin\omega T_n\right]=$$
$$=\sum_{n=0}^{14}(-1)^n a_n\cdot\cos\omega T_n-j\cdot\sum_{n=0}^{14}(-1)^n a_n\cdot\sin\omega T_n. \quad (5)$$

To calculate the module (ч) AOTF characteristics:

$$ч=H(\omega)=\sqrt{\left(\sum_{n=0}^{14}(-1)^n a_n\cdot\cos\omega T_n\right)^2+j\cdot\left(\sum_{n=0}^{14}(-1)^n a_n\cdot\sin\omega T_n\right)^2}. \quad (6)$$

To calculate the argument (φ) characteristics AOPF:

$$\phi=H(\omega)=arctg\frac{\sum_{n=0}^{14}(-1)^n a_n\cdot\cos\omega T_n}{\sum_{n=0}^{14}(-1)^n a_n\cdot\sin\omega T_n}. \quad (7)$$

According to these calculations, for the wavelength λ = 1.55 microns most optimal number of pins turned 14 at the given size pin height of 1 mm., the distance between the electrodes is 1 mm and a thickness of 0.5 mm.

These discussions hava the following key benefits:

1) wide tuning range (200 nm.);
2) narrowband;
3) short switching times;
4) Most importantly, the ability to switch between any number of channels (operating at different frequencies) simultaneously and independently of each other. The lightweight set-up and amplifiers;
5) The ideal selectivity.

In addition, the use of amplifiers, frequency acousto-optic tunable filters have almost rectangular amplitude-frequency characteristic (AFC) and provide the ideal selectivity, good mass and dimensions parameters as well ass ease of configuration and adjustment of the amplifiers.

Also the set of main features of the characteristics, parameters and properties of AOTF are used in high-speed fiber-optic data transmission systems.

Thus, it is shown that the most promising acousto-optical filters are AOTF based on niobate-lithium, that have the best technical parameters for use in IDF and can improve the spectral characteristics of the emitted signal.

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