# Photoelectric transducer based on the use of Mouarov's effect

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Nearly all automated and robotized systems necessitate the measurement of linear shiftings through executive mechanisms with small constructional dimensions with enhanced positioning accuracy. To satisfy this necessity, a number of such mechanisms have been designed and are operatingd in practice [1–3].

The aim of the development here described was the design of an executive mechanism and linear-shiftings sensor with reduced dimensions and high positioning accuracy, suitable for exploitation in space aircraft, too.

A piston photoelectric transducer based on the use of Mouarov's effect is proposed, combining the functions of an executive mechanism and a linear-shiftings sensor [4].

The piston photoelectric transducer based on the use of Mouarov's effect consists of three cylinders *1*, *2* and *3* (Fig. 1). On cylinders *1* and *2*, by a photolithographic method, concentric hatches are marked, satisfying condition:
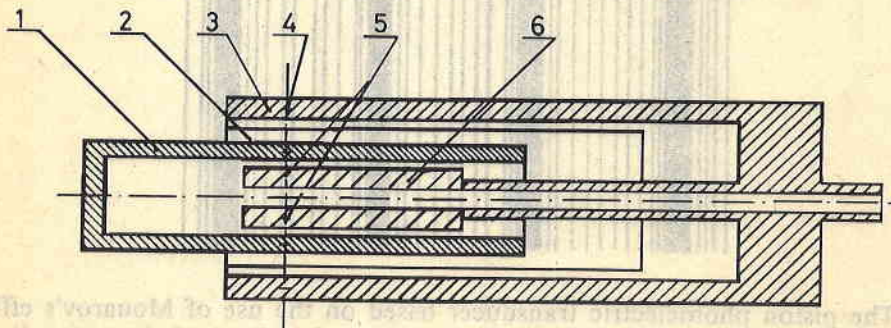


Fig. 1

$$\omega_1 = \omega; \quad \omega_2 = \omega + \Delta\omega \text{ and } \varphi_1 = \varphi_2 = \frac{\pi}{2}, \tag{1}$$

where $\omega_1 = \omega$ is the distance between two adjacent hatches of cylinder *1*;
$\omega_2 = \omega + \Delta\omega$ – the distance between two adjacent hatches of cylinder *2*;

$\varphi_1 = \varphi_2 = \dfrac{\pi}{2}$ – the angle at which the hatches of the 1st and 2nd cylinder are drawn with respect to the $x$-axis.

On cylinder 3, light-diodes $4_i$ are fixed which form opto-electronic couples with photo-diodes $5_i$.

Substituting conditions (1) in the equation of Mouarov's combination stripes, we obtain:

$$(2) \qquad W = \frac{\omega_1 \, \omega_2}{\sqrt{\omega_1^2 + \omega_2^2 - 2\,\omega_1\,\omega_2\,\cos(\varphi_1 - \varphi_2)}}$$

and

$$(3) \qquad W = \frac{\omega_1 \, \omega_2}{\omega_2 - \omega_1} = \frac{\omega(\omega + \Delta\omega)}{\Delta\omega},$$

where $W$ is the distance between two adjacent combination stripes.

From here, about $x$-axis:

$$(4) \qquad x = \frac{p\,\omega_1\,\omega_2 + c_1\,\omega_2 - c_2\,\omega_1}{\sqrt{\omega_1^2 + \omega_2^2 - 2\,\omega_1\,\omega_2\,\cos(\varphi_1 - \varphi_2)}}$$

$$= \frac{p\,\omega_1\,\omega_2 + c_1\,\omega_2 - c_2\,\omega_1}{\omega_2 - \omega_1}$$

$$= \frac{p\,\omega(\omega + \Delta\omega) + c_1(\omega + \Delta\omega) - c_2\,\omega}{\Delta\varpi},$$

where $c_1$, $c_2$ are the distances at which the first hatches of the two scales on the $x$-axis are located; $p$ is the successive number of the combination stripe.

From expression (4), it follows that, in this case, the combination Mouarov stripes are parallel to the $y$-axis (Fig. 2).
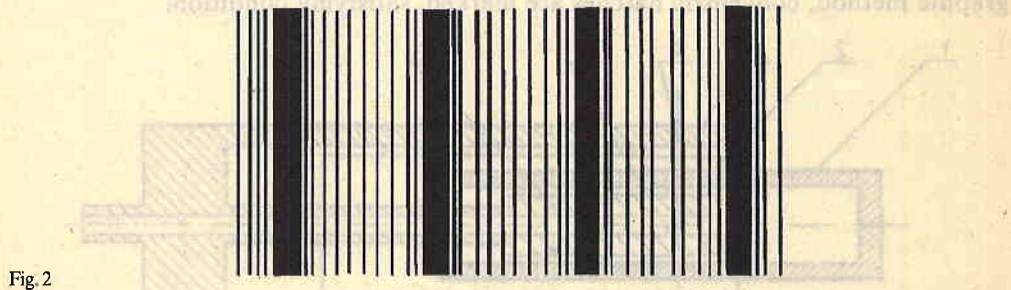


Fig. 2

The piston photoelectric transducer based on the use of Mouarov's effect, operated in the following way. On change of pressure in front of piston 6, cylinder 1 moves forward or backward depending on the direction of change of this pressure. Here, a linear relationship between pressure and mechanical shifting is assumed. On movement of cylinder 1 in either direction, the light flow from light-diodes $4_i$ is modulated by the Mouarov combination stripes. On formation and

amplification of the electric signals from photo-diodes $5_1$, two logical levels are obtained – a logic "0" and a logic "1".

The low electric potential of the logic "0" results from the low level of the light flow, and the electric potential of the logic "1" – from its high level. The transition from "0" to "1" and vice versa corresponds to the shifting of Mouarov's combination stripe.

With a view to reducing external noise, the light- and photo-diodes operate in the infrared section of the spectrum optic range. The laboratory experiments showed, however, that this is not enough, so additional noise-proof coding of the light-flow had to be made.

As a result of the unification of the sensor and the executive mechanism, the operational parameters of the transducer are reduced, and the use of Mouarov's effect increases the accuracy of the linear shifting registration.

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## Фотоелектричен преобразувател с използване на ефекта на Муаров

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(Резюме)

Обект на статията са предложените метод и реализация на бутален фотоелектричен преобразувател с използване на ефекта на Муаров, в който се обединяват функциите на изпълнителния механизъм и сенсора за линейни премествания. Като резултат се повишава точността на отчитане на линейното преместване при намалени габарити на преобразувателя, което го прави подходящ за експлоатация и в космически летателни апарати.