ISSN 2433-202x
JOURNAL DOI 10.37057/2433-202x
www.journalofresearch.asia
info@journalofresearch.asia

OPTOELECTRONIC CONVERTER OF COCOON SHELL DENSITY

Butaev Tukhtasin

Kokand branch of the Tashkent State Technical University, Uzbekistan

Crossref **http://dx.doi.org/10.37057/2433-202x**
Issue DOI http://dx.doi.org/10.37057/2433-202x-209-2020-7-9
Article DOI http://dx.doi.org/10.37057/2433-202x-2020-7-9-16

Abstract

A method based on irradiation of a part of a cocoon not darkened by a pupa, which excludes the influence of interference on the accuracy of control of the cocoon, and a block diagram of a device implementing this method are considered. It is shown that the most effective optical scheme for constructing an optoelectronic converter is a scheme with spatially distributed emitters and photodetectors, which excludes the influence of oscillations of the controlled cocoon in the control zone. A functional diagram is presented and the principle of operation of an optoelectronic converter for the density of a cocoon shell, built on the basis of the proposed optical scheme, is considered

Keywords: cocoon; cocoon pupa; shell; optoelectronic converter; emitter; diode; photodetector; density; error; amplifier; analog key; trigger; sensor.

Introduction. When preparing silkworm cocoons for unwinding, careful factory sorting is required to the grade. Since it is impossible to produce raw silk of a given density, high quality and maximum yield of raw silk from a mixture of cocoons and to obtain maximum labor productivity [1].

Grouping (sorting) of cocoons according to the most information-intensive technological parameters - the density of the shells makes it possible to produce high-quality products, increase labor productivity and, most importantly, contributes to the rational use of raw materials and to increase the yield of raw liquor.

Currently, there are various methods, and the most promising method for controlling the density of cocoons is the optical method, which differs from other methods:

1) versatility, allowing you to control the complex of technological parameters of cocoons;

2) contactless control, which is the main torch for the cocoon shell, since any contact interaction with it is undesirable [2];

3) how easily amenable to automation.

And also, in connection with the automation of production, sensors for measuring and monitoring the density of cocoons and other parameters that characterize technological processes have become very important.

The basis of an optoelectronic converter (OC) is an elementary optocoupler consisting of an emitter (E), an photo detector (PH.D) and an open optical channel, where the controlled cocoon (CC) is located [3].

A simple optical scheme for building an optoelectronic converter (OC) is shown in table. 1, fig. 1. The principle of operation is based on the interaction of radiation I and transformations into an electrical signal (PH.D current). But, the scheme has several disadvantages:

1- the radiation flux interacts not only with the shell of the cocoon (cocoon), but also with

ISSN 2433-202x
JOURNAL DOI 10.37057/2433-202x
www.journalofresearch.asia
info@journalofresearch.asia

the pupa (interference) located inside the shell, as a result of which the resulting signal will depend on the position (coordinate) of the latter between the walls of the cocoon;

the resulting signal PH D will also depend on the coordinates (X and Y) of the cocoon between E and PH D;

the control result will be influenced by the geometrical dimensions (volume, caliber) and the shape of the cocoon;

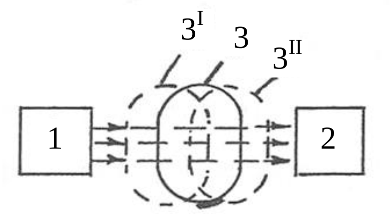
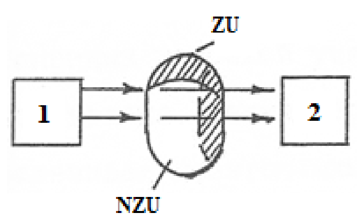
To exclude the influence of the pupa on the control accuracy, a method was proposed [4, 5], which is based on irradiation of the cocoon area not shaded by the pupa. The essence of the method can be explained according to the optical scheme shown in Table 1, Fig. 2, where NZU is the area of the cocoon that is not shaded by the pupa, ZU is the area of the cocoon shaded by the pupa. Thus, by forming a narrow radiation flux I and shining through the parts of the cocoon not shaded by the pupa, the control accuracy can be increased.

The block diagram of the device [6] that implements the above method is shown in Fig. 1.

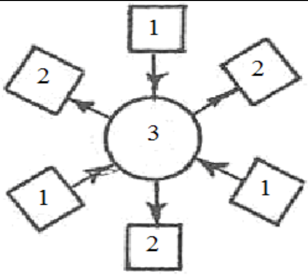
The device consists of an emitter 1, a photo detector 4, a differentiating amplifier 5, the first 6 and second 7 diodes, a trigger with a counting input 8, an analog key 9, threshold devices with a set threshold (10, 11, 12), triggers with separate inputs (13, 14, 15), electronic keys (16, 17, 18) and actuators (19, 20, 21).

The device works as follows. The controlled cocoon 2 passing between the emitter 1 and the photo detector 4 is illuminated by the radiation flux coming from the emitter 1. The transmitted radiation flux is recorded by the photo detector 4 and converted into an electrical signal. The level of the electrical signal at the output of the photo detector 4 will depend on the presence of a cocoon between the emitter 1 and the photo detector, as well as on the section of the shell, i.e. section with or without pupa 3. If there is no cocoon, then the signal at the output of the photo detector will be maximum (see Figure 2, a) (o- t_1). If there is a part of the cocoon with interference in the transmission zone, the signal at the end of the photo detector 4 will be minimal (t_1 - t_2), and if there is a cocoon without interference, the signal level will lie between the maximum and minimum signals ($t_2 - t_3$). The level of this signal will be proportional to the density of the cocoon shell.

Table I

№ рис.	Optical schema	Error
1		$\sum\Delta=\Delta_{pupa}+\Delta_{form}+\Delta_{dyn.err}+\Delta_{posit}$
2		$\sum\Delta=\Delta_{form}+\Delta_{posit}+\Delta_{dyn.err}+\Delta_{meth.err}$

ISSN 2433-202x
JOURNAL DOI 10.37057/2433-202x
www.journalofresearch.asia
info@journalofresearch.asia

3		$\sum\Delta = \Delta_{meth.err} + \Delta_{dyn.err}$

The electrical signal of the photo detector 4 is fed to the inputs of the differentiating amplifier 5 and the analog switch 9. At the output of the differentiating amplifier 5, signals appear corresponding to the 3-rd sections t_2, t_3, t_1 (see Figure 2, b). These signals through the first diode 6 are fed to the trigger input with the counting input 8 and through the second diode 7 to the reset input of the trigger with separate inputs 13, 14, I5. A trigger with a counting input 8 controls the operation of an analog switch 9, i.e. at time t_2 it opens it, and at time t_3 it turns it off. Thus, an electrical signal proportional to the density of the cocoon shell is allocated and the influence of interference on the control result is excluded. Then the signal is fed to the inputs of threshold devices with a set threshold of 10, 11, 12 and, depending on the signal level, a pulse appears at the output of one of the threshold devices and the corresponding trigger with a separate input is transferred to state "1". The electronic key corresponding to this trigger, that is, with the state "1", it gives a signal to activate the corresponding actuator for sorting the cocoon with a certain density.

When another cocoon hits between the emitter and the photo detector, the triggers with separate inputs 13, 14, 15 are reset using the signal generated by the second diode 7.

The considered device according to the optical scheme (see Table 1, Fig. 2) does not exclude the influence on the control result of the position (coordinates) of the cocoon between E and PH.D and the geometric dimensions (volume, caliber) and shell shape.

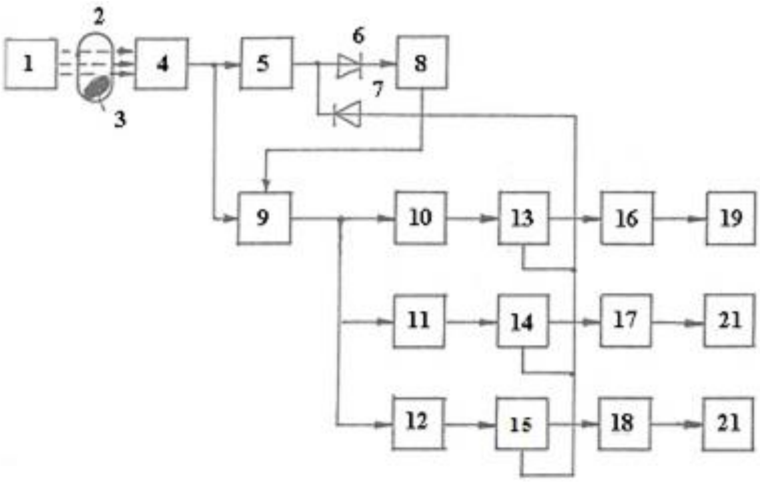


Fig.1 Block schema of the device for controlling the density of the cocoon shell.

ISSN 2433-202x
JOURNAL DOI 10.37057/2433-202x
www.journalofresearch.asia
info@journalofresearch.asia

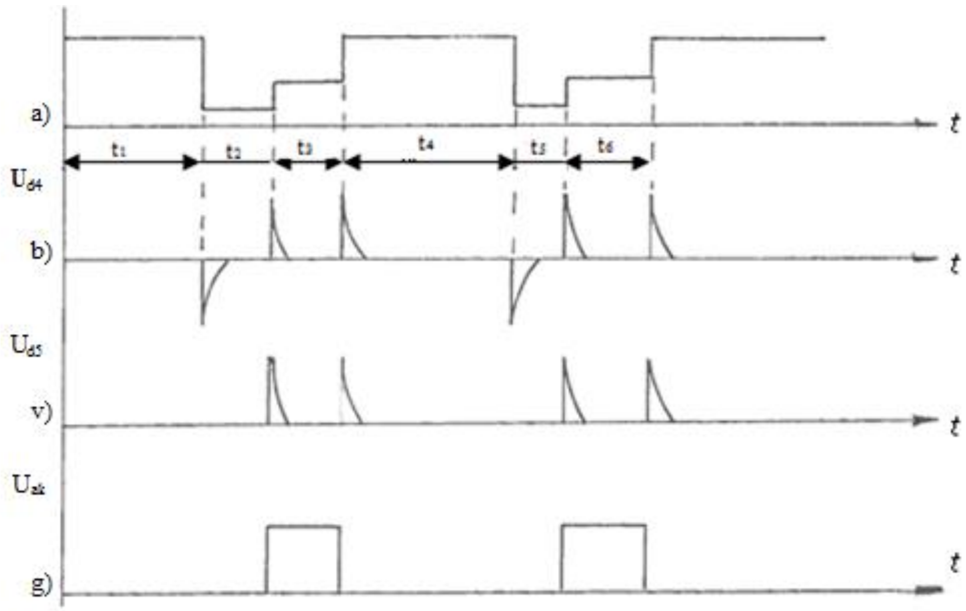


Fig. 2 Timing diagrams.

To eliminate the influence of oscillation of the controlled cocoon in the control zone, an optical scheme with spatially distributed emitters and photo detectors is proposed [7]. The essence of the proposed principle (Fig. 3 from Table 1) is that the controlled cocoon is illuminated from all sides by spatially distributed emitters and streams separated in time, and streams received from all directions are converted into a photoelectric signal by the corresponding spatially distributed photo detectors.

Figure 3 shows a functional diagram of a cocoon shell density converter built on the basis of the above optical scheme.

The converter works as follows. The master generator 4 generates a periodic sequence of rectangular pulses and through the switches 5 the emitting diodes I (a, b, c) and the corresponding photo detectors 2 (a, b, c) are alternately turned on. Sequential cyclic switching in time of pairs of opposite E-PH.D elements excludes the reception of radiation from a neighboring E.

The stream passed through the cocoon is converted by the photo detector into an electrical signal and through the switch 5 is alternately fed to the input of the photoelectric signal processing unit 6 and then to the recording device 7.

The flight of the controlled cocoon through the control zone is random. Since the diameter of the sensor control zone is larger than the diameter of the cocoon Rк. Therefore, the controlled cocoon 3, when passing through the control zones, can fluctuate randomly. Let's consider the general case.

Asian Journal of Research № 7-9, 2020
IMPACT FACTOR
SJIF 6,3
IFS 6,8
ISSN 2433-202x
JOURNAL DOI 10.37057/2433-202x
www.journalofresearch.asia
info@journalofresearch.asia

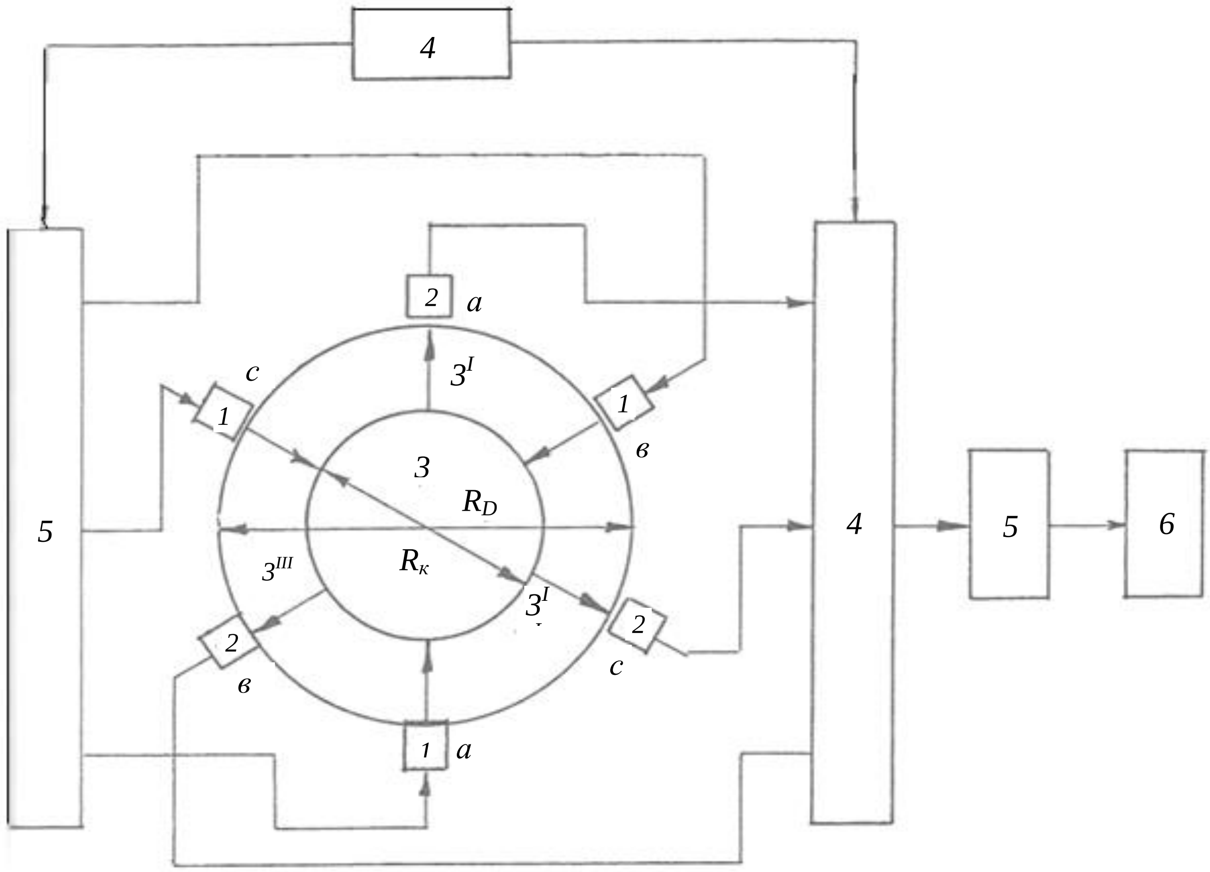
The total number of photo detectors (PH.D) along the circumference of the sensor is equal to N, N_{oi}- the number of PH.D s simultaneously distant from the shell edge by (K → PH.D); N_δ - the number of PH.D s simultaneously close to the extreme point of the shell with distance (K → PH.D).

Fig. 3. Functional diagram of the optoelectronic sensor for the density of the cocoon shell. where: I - emitters; 2 - photodetectors; 3 - cocoon; 4 - master oscillator; 5 - switches; 6- photoelectric signal processing unit; 7- recording device.

If the cocoon is in the center of the sensor, then for all photodetectors the distance to the edge of the shell will be the same. We consider the emitting diodes to be point and the same in power and directional pattern. Then the output signals of the PH.D will be:

$$U_{P1} = U_{P2} = U_{P3} = \ldots\ldots\ldots = U_{PN} \quad (1)$$

If the cocoon occupies a random position in the control zone, then the number of PH.Ds distant by equal (R_D-R_K) io distances from the shell edge N_{io} and the number of PH.Ds closely located (K → PH.D) i_δ to the shell edge $N_{i\delta}$ will be equal to:



$$N_{oi} = N_{i\delta} \quad (2)$$

Indeed, if we assume N → ∞, then the points of the PH.D location take the circle equal to $\pi R^2 D$. The ratio of the sensor circumference and the monitored cocoon will be:

$$\pi R_D^2 - \pi R_K^2 = \pi(R_D^2 - R_K^2) = const \quad (3)$$

so how $R_D = const$ and $R_K = const$

It is known /8/ that the power of the flux incident on the photodetector is inversely proportional to the square of the distance from the source to the photodetector.

ISSN 2433-202x
JOURNAL DOI 10.37057/2433-202x
www.journalofresearch.asia
info@journalofresearch.asia

Thus, for the second case, the output signals of the PH.D will be:

$$\sum_{i=1}^{N_{oi}} U_{P_{oi}} > \sum_{i=1}^{n_{s_i}} U_{P_{s_1}} \quad (4)$$

From relations (1), (2), (3) and (4) it is not difficult to start:

$$\sum_{i=1}^{N} U_{P_1} = const \quad (5)$$

The number of photo detectors is limited in terms of efficiency, switching complexity and signal processing.

Consider a sensor with three optocouplers $1_{a,b,c}$ - $2_{a,b,c}$ at four possible positions of the cocoon in the monitoring zone. In Fig. 3, three positions are shown with a dotted line (3^I, 3^{II}, 3^{III}).

When the cocoon is in the center of the sensor 3, the distance from its edge of the shell to the emitting diodes $1_{a,b,c}$ and photo detectors $2_{a,b,c}$ are equal, i.e .:

1_a-$k=1_b\rightarrow k=1_c\rightarrow k=k\rightarrow 2_a=k\rightarrow 2_b=k\rightarrow 2_c$

where: *k* - shell edge point.

In this case, we assume that emitting diodes with the same directional patterns and point. Then, for the output signals of photodetectors 2_a, 2_b, and 2_c, the following relation is valid:

$$U_{f_{2a}} = U_{f2b} = U_{f2c} \quad (6)$$

If the cocoon is in position 3^I, then ($1_a \rightarrow$ k)> (k $\rightarrow 2_a$), i.e. it is close to the photodetector 2_a. At the same time, it is equally distant from 2_b and 2_c. Thus, we can write the following relations for the position of the cocoon 3^I:

$$(1_a\text{-}k) > [(1_b\rightarrow k) = (1_c\rightarrow k)] \quad (7)$$

$$(k\rightarrow 2_a) < [(k\rightarrow 2_b) = (k\rightarrow 2_c)] \quad (8)$$

Therefore, the ratio of the output signals of the photodetectors will be:

$$U_{f_{2a}} > (U_{f2b} = U_{f2c}) \quad (9)$$

imilarly, for two positions 3^{II} and 3^{III} of the cocoon, we write the following relations:

for 3^{II}

$$(1_c\rightarrow k) > [(1_b\rightarrow k) = (1_a\rightarrow k)]$$
$$(k\rightarrow 2_c) < [(k\rightarrow 2_a) = (k\rightarrow 2_b)]$$
$$(1_c\rightarrow k) > (k\rightarrow 2_c)$$
$$U_{f2c} > (U_{f2b} = U_{f_{2a}} \quad (10)$$

for 3^{III}

$$(1_b\rightarrow k) > (k\rightarrow 2_b)$$
$$(1_b\rightarrow k) > [(1_a\text{-}k) = (1_c\rightarrow k)$$
$$(k\rightarrow 2_b) < [(k\rightarrow 2_a) = (k\rightarrow 2_a)]$$
$$U_{f2b} > (U_{f_{2a}} = U_{f2c}) \quad (11)$$

From the relations (6), (8), (10), and (11) you can write:

$$U_{\Phi 2a} = U_{\Phi 2b} = U_{\Phi 2c} = const.$$

ISSN 2433-202x
JOURNAL DOI 10.37057/2433-202x
www.journalofresearch.asia
info@journalofresearch.asia

References

1. Rubinov E.B. Silk technology - M .: Light and food industry, 1981-392s.
2.Mukhamedov M.M., Kolomonova N, B. Damage to the casings of cocoons during preparation for unwinding. - Silk, ref.n.-t collection, 1986, No. 2, p.16-18.
3.M.M.Miroshnichenkov. Theoretical foundations of optoelectronic devices - L.: Mashinostroenie, 1983-696 p.
4. A.S. No. 1308898 (CCCP) Method for determining the density of the shell of the cocoon /M. M. Mukhitdinov, E. S. Musaev and T. Butaev - publ. B. I., 1987, No. 17.
5. A.S. No. I393376 (CCCP) Method of sorting cocoons and a device for its implementation / Musaev ES, Butaev T. - publ "BI", 1988, No. 17.
6. Mukhitdinov M., Musaev E.S. and T. Butaev. Small-sized sensor for monitoring the technological parameters of cocoons 0DP-2M / prospect - Tashkent, Vneshtorg.izdat, 1988-2s.
7. Musaev ES, Butaev T. Optoelectronic converter of technological parameters of cocoons on coordinate-sensitive photodetectors - In the book: Abstracts of the III All-Union meeting "Optical scanning devices and measuring devices based on them". Barnaul, 1986, part 1, p. 205.
8. Klimkov Yu.M. Basics of calculating optoelectronic devices with lasers - M .: Sov.radio, 1978-264p.