Enhanced Alignment Method For Facet Of Concentrator Of Solar High-Temperature Equipment

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Abstract: In this article argued base on the analysis of the properties of the mutual arrangement of normal to the ideal paraboloid surface, an optimal method and device for adjusting the facet of the concentrator have been developed.

Index Terms: adjustment accuracy, concentrator, facet, facet adjustment, focal plane of the concentrator, normal setting device, reflecting surface, zone of minimum dimensions.

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1. INTRODUCTION

The sun is considered as one of the sources of energy, which can play a significant role in the development of the economy of certain territories of the globe, especially in areas with a large number of clear days. However, the flux density of solar radiation at the Earth's surface is relatively low and does not provide the temperatures necessary to solve important problems such as the implementation of high-temperature processes [1,2,3,4]. The technological problem of obtaining ultrapure materials and alloys, beam welding can be successfully solved using mirror concentrating systems. The solutions for this problem include a number of problems, and in particular, way the observance of the shape and size of individual elements and the entire complex as a whole, and the accuracy of their mutual arrangement and orientation.

2 METHODS OF RESEARCH

A large-sized concentrating surface can be formed by a set of spherical mirrors mounted on the surface of the Paraboloid in such a way that all individual images overlap each other in its focus. Since the reflective surface of the concentrator is formed from individual spherical facets, its geometric accuracy is determined by the accuracy of the manufacture of the surface of these facets and their location. No matter how perfect the individual facets are, their results are incorrect. Therefore, after installation and during the operation of the hub, it is required to adjust the alignment of the individual facets of the concentrator to the required spatial position on the supporting frame and orient of normal to the center of each facet. A number of known methods for adjusting the facet of a concentrator are the need for a significant number of settings device that sets for normal. In order to eliminate this drawback, we analyzed the properties of the relative position of the normals to the ideal paraboloid surface [5,6,7,8]. The obtained parabola properties in can be used to optimize the alignment process of the concentrator of a solar installation. The area in which all the normals intersect to the surface of the paraboloid will serve as the zone of minimal displacements of the device for setting normals.

From the obtained [2] formulas

$$X_R = X_{np} = \frac{\ldots}{\ldots}$$ [1].
$$Y_R = Y_{np} = \frac{\ldots}{\ldots} + p$$

It is visible (where Xpr, Ypr are the coordinates of the points of the device settings) that to determine the coordinates of the points of intersection of the normals to the surface of the parabola, with a zone of minimum size, you need to know the coordinates of the points of the parabola. The task is to determine the coordinates of the points of the parabola taken on it sequentially through a certain given distance L. Since the distance L between the centers of the adjustable facets has a small length, then it can be taken equal to the arc of the curve in parabola.

It is known [3] that the arc length of the curve y = y (x) is calculated by the formula:

$$L = \int_{\ldots}^{x_2} \sqrt{1 + y'^2}\,dx. \quad (2)$$

Formula (2) for the function $Y = \frac{\ldots}{\ldots}$ (2) can be written as

$$L = \int_{\ldots}^{x_2} \sqrt{1 + \frac{\ldots}{\ldots}}\,dx. \quad (3)$$

or

$$L = \frac{\ldots}{\ldots} \int_{\ldots}^{x_2} \sqrt{P^2 + x^2}\,dx. \quad (4)$$

Integrating it, we get

$$L = \frac{\ldots}{\ldots} X_2\sqrt{X^2 + P^4} + P^2 ln\left(X_2 + \sqrt{X_2^2 + P^2} \right) - X_2\sqrt{X_1^2 + P^2} + P^2 ln\left(X_1 + \sqrt{X^2 + P^2}\right). \quad (5)$$

By entering the notation

$$A(x) = X\sqrt{X + P^2} + P^2 \ln\left(X + \sqrt{X^2 + P^2} \right),$$

We have

$$A(x) - A(X_1) - 2PL = 0 \quad (6)$$

To find the roots of expression (6), we use Newton's iterative method [3].

Then the iterative process of finding the root of the considered equation is realized by sequential use of the formula

$$X_{n+1} = X_n - F(X_n)/F'(X_n) \quad (7)$$

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$$|X_{n+1} - X_n| \le \varepsilon, \quad (8)$$

where F (X) is the left side of expression (6), E is the given accuracy of calculating the root of X. According to this

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program, it is possible to calculate the coordinates of the points of the parabola. It has taken sequentially through a certain predetermined distance L, the coordinates of the installation points of the device Xpr .; Control; the distance S from the point of intersection of the axis of the concentrator with the BB region's minimum dimensions to the centers of the aligned facets. A device is proposed for installation and movement in the BB 'region of the device that sets the normal to the surfaces of the facets being adjusted, the circuit of which is shown in Fig. 1.

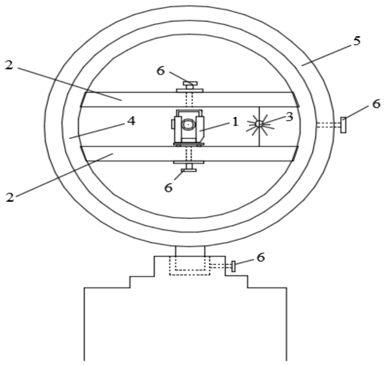

Fig. 1*. The device that sets the normal hub axis heights.to surfaces of adjustable facets*

The adjustment process according to the proposed method is carried out in the following order. From the top of the paraboloid, in the direction of the optical axis of the concentrator, put the distance D, where the proposed device is located. In the center of the device, a theodolite with an auto-reflection mark is installed, so the axis of rotation of the visual the pipes were level normal hub axis heights.

3 RESULTS AND DISCUSSIONS

The optical axis of the telescope is directed to the center of the central facet. Rotating the adjustment screws of the central facet combine the image of the mark reflected from the adjusted facet with the auto reflective mark of theodolite, i.e. normal to the center of the central facet combine with the axis of the hub. When proceeding with the adjustment of the next facet, theodolite movesThey walk along the guides to a new position previously calculated by formulas (1), the fixation of which is carried out on the millimeter scales of the guides with an accuracy of 0.1 mm. Then, the target axis of the theodolite pipe is pointed at the center of the facet being adjusted and its normal screws are aligned with the target axis with its adjustment screws. To adjust the facet located in the other (subsequent) branches of the parabola, rotate the inner ring of the device until the optical axis of the telescope hits the center of the facet being adjusted, after which the facets combine their normal with the sight axis of the telescope by turns. Quadratic error of fixing the installation site of theodolite Mf, average. the quadratic error of combining the auto-reflection brand with its reflection from the facet of the Msov and the average. the quadratic error of the assembly of the facet - MSB., i.e. discrepancy between the real I (Fig. 2) position of the facet with theoretical 2

From Fig. 2. it is seen that the value of the Mdr. calculated by the formula

$$M\_dr=(\Delta S\cdot \sin\varphi P)/f^{1} \quad (9)$$

Where ΔS is the facet bias error, φ is the deviation angle, ƒ -focal length.
From here we get

$$\Delta S=(m\_dr\cdot f^{1})/(\sin\varphi\cdot P)$$

The calculation data for ΔS and f, after 1 m along the parabola arc are given in table No. 1.

Table 1*. the MSB value for different sections*

	,8º	,4º	3,9º	8,1º	2,1º	5,7º	9,1º
f мм	042	165	367	643	988	393	854
S мм	6,2	4,	7,0	3,7	1,9	0,9	0,3

From table No. 1. it can be seen that the MSB value for different sections of the concentrator is not the same. Most accurately, it is necessary to install facets on the peripheral parts of the concentrator. Therefore, with ΔS = 11 mm, the accuracy of the alignment method does not exceed 2.2.

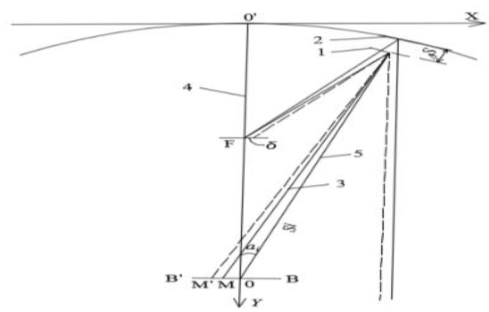

Fig 2. *Autoreflexin method of concentrator facet adjustment and concentrator adjustment*

4 CONCLUSION

Thus, on the basis of theoretical studies, a simplified method and device for adjusting the facet of a concentrator is proposed, the distinguishing feature of which is that the movement of the device that sets the normals is performed in the region of minimum dimensions. Using the proposed method and device will allow alignment of the facet of the concentrator and obtain accuracy.The device will allow to optimize the method of assembly and alignment of the facet of the concentrator and get adjustments characterized by the average, the square error of $1\text{-}2^{l}$.

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