ISSN 2347 - 3983
Volume 8. No. 7, July 2020
International Journal of Emerging Trends in Engineering Research
Available Online at http://www.warse.org/IJETER/static/pdf/file/ijeter77872020.pdf
https://doi.org/10.30534/ijeter/2020/77872020

Kinematic study of the cam mechanism by the method of diagrams

Smirnova, Z.V.[1], Vaganova O.I.[2], Cherney O.T.[3], Bystrova, N.V.[4], Golubeva O.V.[5]
[1]Minin Nizhny Novgorod State Pedagogical University (Minin University), Nizhny Novgorod, Russian Federation, z.v.smirnova@mininuniver.ru
[2]Minin Nizhny Novgorod State Pedagogical University (Minin University), Nizhny Novgorod, Russian Federation, vaganova_o@mail.ru
[3]Minin Nizhny Novgorod State Pedagogical University (Minin University), Nizhny Novgorod, Russian Federation, fiolet1975@mail.ru
[4]Minin Nizhny Novgorod State Pedagogical University (Minin University), Nizhny Novgorod, Russian Federation, bystrova_nv@mail.ru
[5]Minin Nizhny Novgorod State Pedagogical University (Minin University), Nizhny Novgorod, Russian Federation, gololga@yandex.ru

ABSTRACT

The article substantiates the construction of kinematic diagrams of motion of kinematic parameters of movement of a mechanism with an off-axis translationally moving pusher. The main tasks of displacements, speeds and accelerations of the pusher are given for a given mechanism scheme and cam profile. Plots of the speed of movement of the mechanism are constructed by the basic methods for constructing kinematic diagrams.

Key words: Kinematic diagram, mechanism, movement, cam.

1.INTRODUCTION

It is customary to call a kinematic diagram a graphic image of the change in one of the kinematic parameters of a link: displacement, speed, or acceleration of a link point of a mechanism under study as a function of time or as a function of a generalized coordinate.

An image of the dependence of the parameters of the movement of mechanisms in the form of graphs makes it possible to visualize their change over a long period. When making schedules for cyclically moving systems, it is enough to limit ourselves to the length of time of one cycle. As you know, the functions of displacement, speed and acceleration of movement of a point or link are interconnected by differentiation or integration operations. Therefore, to determine all these functions, it is enough to have a diagram of one of them. Diagrams of other functions can be constructed by graphical differentiation or graphical integration of a given function.

2.RESEARCH

The main objective of kinematic analysis is to determine the movements, velocities and accelerations of the pusher for a given mechanism diagram and cam profile. The solution to this problem can be carried out by analytical or graphical methods, the first of which is more accurate, but complex, and the second is less accurate, but simple.[1]

In the study of cam mechanisms, the kinematic diagram method is most often used. To apply this method, it is necessary to determine the pusher movement diagram. Since the cam mechanism is specified in the kinematic analysis, its kinematic scheme and the shape of the cam structural profile are known.

Consider the construction of a displacement diagram for a mechanism with an off-axis translational moving pusher:

– a family of circles with a radius equal to the radius of the roller is constructed with respect to the structural profile of the cam; the centers of the circles of this family of a smooth curve are connected and the center or theoretical profile of the cam is obtained

– circles of radii r0 and r0 + hAmax fit into the obtained center profile, the eccentricity e

– by the size of the sections that do not coincide with arcs of circles of radii r0 and r0 + hAmax, phase angles jrab, jy, jдв and jc are determined

– the arc of a circle r corresponding to the working phase angle is divided into several discrete sections; straight lines are drawn through the break points relative to the circle of the radius of the eccentricity (these lines correspond to the positions of the axis of the pusher in its movement relative to the cam)

– on these straight lines the segments located between the center profile and a circle of radius r0 are measured; these segments correspond to the displacements of the center of the roller of the pusher SBi. Based on the obtained displacements SBi, a diagram of the position function of the center of the pusher roller SBi = f (j1)

3.RESULT AND DISCUSSION

We construct a diagram of the movement of the pusher of the central cam mechanism with a pointed pusher. The cam performs a uniform rotational movement with an angular velocity ω. If the whole mechanism is mentally given rotation with an angular velocity equal in value to the given angular velocity of the cam ω, but opposite in direction, then the cam will become stationary and the pusher will rotate in the opposite direction to the actual rotation of the cam with angular velocity ω. The movement S of the pusher depending on the angle of rotation of the cam is determined as follows. From point O, a circle is drawn with the smallest radius of the cam profile, which is divided into an equal number of parts (cam rotation angles).[2]

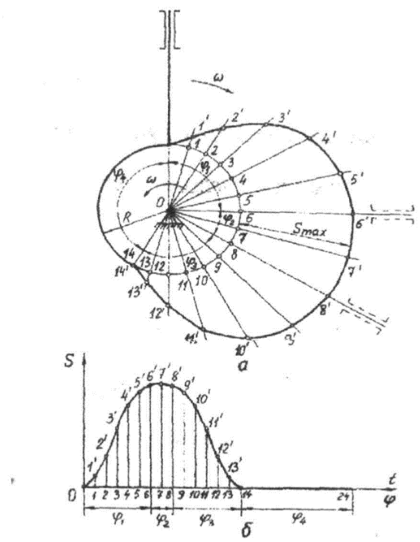

Figure 1: Diagram of the movement of the pusher of the central cam mechanism with a pointed pusher.

The reference point is usually taken as the position of the pusher corresponding to the beginning of its rise, and the points are counted in the direction opposite to the direction of the given angular velocity ω.[4]
Continuing the radius - the vectors of a circle of radius R to the intersection with the cam profile, we obtain segments 1 - 1 ', 2 - 2', 3 - 3 ', etc.
Then, by choosing a coordinate system or, on the abscissa axis, we postpone a segment of an arbitrary length L mm, which in scale is equal to the cam rotation period T (or the cam rotation angle by 2π). We break this segment into the same number of parts as the circle R. In this case, the time scale t will be:
Mt = (s / mm), where n is the cam rotation frequency (r / min), and the rotation angle scale is φ = ω
Mφ = (rad / mm).
From each point 0, 1, 2, 3 ... the abscissa axis, draw a line parallel to the ordinate axis, and on it we postpone segments proportional to the movements of the pusher, etc. in scale
Ms = Smax / Hmax. Connecting the points 0, 1 ′, 2 ′ ... of a smooth curve, we obtain a diagram of the movement of the pusher. For ω = const, the curve S (t) = S.
An example of constructing a plunger displacement graph S = S (t) or S = S is shown in the figures.

3.1Construction of a diagram of the speeds of the pusher according to the schedule of movements

The graphs of the velocity u = u (t) and acceleration a = a (t) are plotted according to the displacement graph S = S (t) by the method of graphical differentiation, the essence of which is as follows.[5]

Draw a tangent at an arbitrary point In the curve S = S (t) (Figure 2.). Let dS be the elementary displacement of a point in a sufficiently small period of time dt.

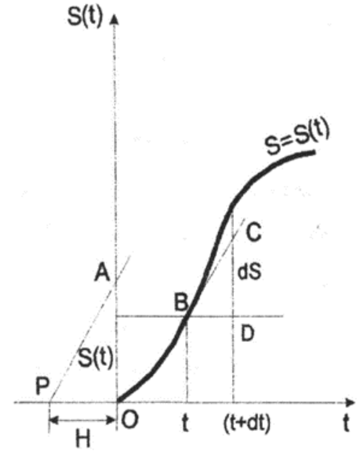

Figure 2: Plotting the speed diagram of the pusher according to the movement chart

From the pole P selected on the abscissa at an arbitrary distance H from the origin, we draw a beam parallel to the tangent. From the similarity of the RAO and BCD triangles, it follows that

$$OA = \frac{CD}{BD}H \quad (1)$$

The elementary displacement dS during the time dt is displayed on the graph by a segment

$$CD = \frac{dS}{\mu_s},$$

Where μ_s - scale of movements.

Section $BD = \frac{dt}{\mu_t}$

displays the duration of the time interval dt to scale μ_t.

Substituting these values CD and BD in equality (1), we find

$$OA = \frac{dS}{dt} \cdot \frac{\mu_t}{\mu_s} \cdot H \quad (2)$$

Attitude $\frac{dS}{dt}$ represents the value of the speed of the pusher at time t.

Thus, as follows from equality (2),

$$u_B = OA\frac{\mu_s}{\mu_t H} \quad (3)$$

If you take the speed scale

$$\mu_u = \frac{\mu_s}{\mu_t H} \quad (4)$$

then from equality (3) it follows that the segment OA displays the value of the speed of the pusher at time t corresponding to point B in Figure 3.

We consider the sequence of graphical differentiation using the example of constructing a velocity graph u = u (t) according to a given displacement graph S = S (t). Divide the abscissa of the curve S = S (t) into n parts. In order to increase the accuracy of the results of graphic differentiation, it is recommended that the abscissas of the individual parts of the curve, characterized by a sharp change in curvature, be divided into smaller sections. Draw to the intersection with the ordinate curve $1-1'$, $2-2'$ etc.

Next, draw the tangents at the points $1', 2', 3',...$ crooked *S=S(t)*. We postpone the pole distance OP = H along the abscissa to the left of the coordinate O. Draw rays parallel to the tangent drawn from the pole P and obtain a series of intersection points on the ordinate $1'', 2'', 3'', 4''....$ Received segments $1-2'', 1-3'',...$, proportional to the speeds of the pusher at the corresponding time instants, we plot the velocity diagram u = u (t) on the ordinates. We connect the received points 1 ″, 2 ″, 3 ″.... smooth curve, which will be a function of the speed of the pusher as a function of time t. The scale of this curve is determined byequality (4).[6]

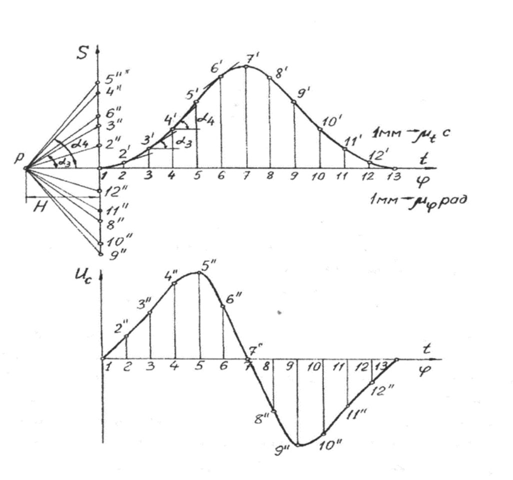

Figure 3: Speed Graphics

3.2Construction of a diagram of accelerations of a pusher on a diagram of speeds

The graph of the acceleration of the pusher is constructed similarly, by differentiating the velocity graph. Draw the tangents at points 1 ', 2', 3 '... of the curve u = u (t) (Figure 5). We postpone the pole distance OP1 = H1 along the abscissa to the left of the coordinate origin (it may differ from the pole distance H). Draw rays parallel to the tangent drawn from the pole, and obtain on the ordinate axis a series of intersection points 1 ", 2", 3 ", ...

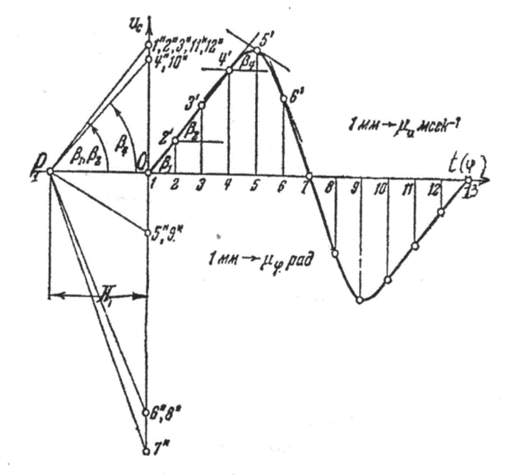

Figure 4: Pusher Acceleration Graph

The obtained segments 1 - 1 ", 1 - 2", 1 - 3 ", ..., proportional to the accelerations of the pusher, we postpone the acceleration diagrams a = a (t) on the corresponding ordinates (Figure 5).[8]

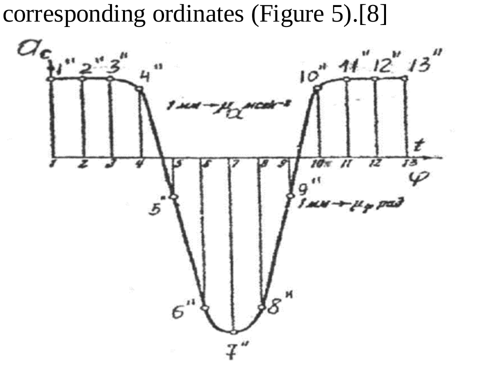

Figure 5: Pusher Acceleration Graph

Equality for determining the scale of the acceleration graph is obtained from equality (4), if we replace the magnitude of the scale μ_S graph of displacement μ_u speed graph scale and substitute H1 instead of H:

$$\mu_a = \frac{\mu_u}{\mu_t H_1}.$$

To determine the true values of the speed and acceleration of the pusher, you need the distances 1 - 1 ", 1 - 2", 1 - 3 ", ... figure 3 (speed) and figure 5. (acceleration) in millimeters multiplied by the scale μ_u or μ_a respectively.[7]

It should be borne in mind that due to the inaccuracy of the graphical differentiation method itself, the velocity diagrams, and especially the acceleration diagrams (double differentiation), can turn out with significant distortions. [3]

4.CONCLUSION

In a kinematic study, all dimensions of the cam mechanism (rocker length, point coordinates, roller radius, profile coordinates, etc.) are considered known. Profile coordinates can be set in analytical (for simple profiles) or in graphical form (drawing or table of points). As a result of a kinematic study, the law of movement of the driven unit is determined. The problem can be solved both analytically and graphically. The analytical solution, as a rule, is used in cases where the cam profile equation is given in the analytical form (special cams).

REFERENCES

[1] Artobolevsky I.I. **Theory of mechanisms and machines** / I.I. Artobolevsky. - 6th ed., Stereotype, reprint. - M .: Alliance Publishing House, 2011.

[2] **Theory of mechanisms and mechanics of machines: Textbook. for universities** / Ed. K.V. Frolova. Recommended min arr. RF - 5th ed. - M.: Higher School, 2005.

[3] **Theory of mechanisms and machines: Textbook for university students: Admittance of the Ministry of Education of the Russian Federation** / M.Z.Kozlovsky, A.N. Evgrafov, Yu.A. Semenov, A.V. Sloushch. - 2nd ed., Rev. - M.: Academy, 2008.

[4] Gushchin A.N., Vorobyeva I.V. **Theory of mechanisms and machines. A set of teaching materials**. Part 1. - N. Novgorod, 2007.

[5]Smirnova, Z.V., Mukhina, M.V., Katkova, O.V., Gruzdeva, M.L., Chernei, O.T. **Network Interaction as a Factor of Professional Qualities' Development of Service Workers**//Lecture Notes in Networks and Systems, 87, pp. 698-704. International Journal of Innovative Technology
https://doi.org/10.1007/978-3-030-29586-8_81

[6]Smirnova, Z.V., Rudenko, A.A., Vaganova, O.I., Cherney, O.T., Mokerov, D.S., Semakhin, E.A. **The research of carbon construction steel at laser alloying** //International Journal of Innovative Technology and Exploring Engineering

[7] Santhosh , K. Hari Kishore , G. Pavani Lakshmi , G.Kushwanth4 , P. Rama Krishna Dharma Teja , R. S. Ernest Ravindran , SreeVardhanCheerala , M. Ravi Kumar Detection of Heavy Metal Ions using Star-Shaped Microfluidic Channel Chella. //**International Journal of Emerging Trends in Engineering Research**. Volume 7, No. 12 December 2019.
https://doi.org/10.30534/ijeter/2019/067122019

[8] O. Amer, A. Salem, A **Novel Leach Routing Protocol using Genetic Algorithm for Wireless Sensor Networks**, International Journal of Advanced Trends in Computer Science and Engineering, Volume 8, No.5, September - October 2019
https://doi.org/10.30534/ijatcse/2019/37852019