Formulating Relations between Linkages of Peaucellier Mechanism

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Abstract— **Straight line motion is very much important and beneficial from mechanical engineering aspects, as most of the machines produce straight line motion at its output and also straight line motion is needed in running different machines or in the designing of different tools and materials. Peaucellier mechanism is one of the exact straight line motion mechanism working on lower pair linkages implying eight links rhomboidal system in such a way so as to produce straight line motion at its output. This project is all about formulating the relations trigonometrically between the lengths of the linkages and the different angles subtended by these linkages so as to calculate accurately the unknown dimensions by the help of given or known values. If the height of the mechanism, and width of the bar are known then we can trigonometrically deduce the lengths of the remaining bars and the stroke length of the mechanism and the different angles forming at different junctions especially the maximum working angle subtended by the crank during its rotation by knowing exactly the maximum working angle we can program the motor accordingly to provide required rotational motion to the crank so as to produce the straight line motion of our desired length.**

Index Terms— **Peaucellier, Straight-line mechanism, Formulating, Relations**

I. Introduction

From the previous centuries, many straight line motion mechanisms have been invented, few of them tracing exact straight line motion and the other following approximate straight line motion ***for example, Peaucellier mechanism, Hart's mechanism, Scott Russell mechanisms are some of the exact straight line motion mechanisms while Watt's mechanism, Tchebicheff's mechanism, Robert mechanisms are some examples of the approximate straight line motion mechanism.*** [1]

Straight line motion may be obtained either by using turning pairs or by using sliding pairs. [2]

Over the centuries, the straight line motion mechanisms are finding a lot of its applications in engineering and manufacturing aspects. In accordance to apply these straight line motion mechanisms and to obtain the maximum output from them, there comes a need of different relations helpful in designing them effectively and also in obtaining highest accuracy from them. ***In this project we are discussing about the Peaucellier Mechanism which is an exact straight line motion mechanism working on turning pairs consisting of eight links rhomboidal system and converting pure rotational motion into pure linear motion***.***This mechanism is invented by a French mathematician and army officer named Charles Nicolas Peaucellier in 1864. [3]***

Although the mechanism has been invented years ago but the work on its dimensional data, formulas or its relations seems to be insufficient to obtain maximum output from this mechanism. Thus the aim of this project is to deduce such relations between its linkage length and the angles so as to increase its output.

II. Calculations

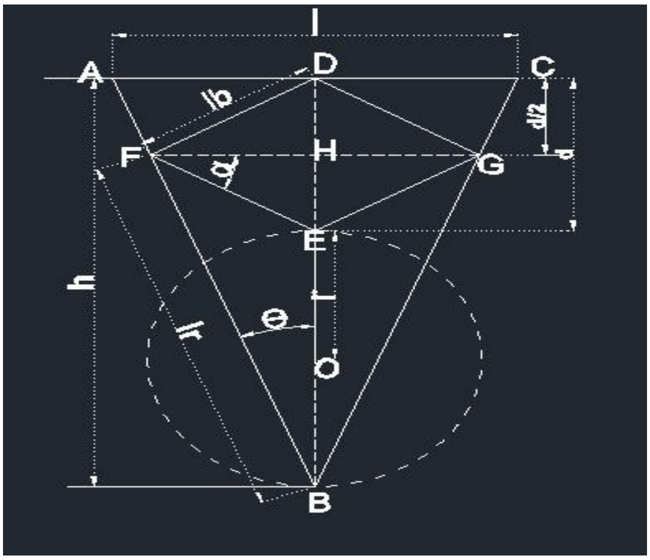

Fig 1.

ASSUMPTIONS:-

1. Values of w and h are to be assumed
2. l = (h/3)
3. d = 2w

Here,
w is the width of the bar,
l is the horizontal length of the mechanism,
h is the vertical height of the mechanism,
r is the length of the crank bar,
l_b is the length of each bar of rhomboidal system,
l_r is the length of rod joining bars of rhomboidal system to the fixed point,
d is the vertical height of the rhomboidal system,
2θ is the angle subtended between the rods joining bars of rhomboidal system to the fixed point,
2r = h-d

In ΔABD,
Tan θ = (AD/BD)
Tan θ = {(l/2)/h}
$\boldsymbol{\Theta = Tan^{-1}\{(l/2)/h\}}$

In ΔBHF,

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$HB = 2r + (d/2)$
$\tan\theta = (FH/HB)$
$FH = HB \times \tan\theta$
$\boldsymbol{FH = \{2r + (d/2)\} \tan\theta}$
In ΔFHE,
$HE = d/2$
$\tan\alpha = (HE/ FH)$
$\boldsymbol{\tan\alpha = \{(d/2) / (2r + (d/2)) \tan\theta\}}$
$\sin\alpha = (HE/FE)$
$FE = (HE/ \sin\alpha)$ $\{FE = l_{b.}, HE = (d/2)\}$
$l_{b.} = \{(d/2)/ \sin\alpha\}$
$\boldsymbol{l_{b.} = \{(d/2)/ \sin\alpha\}}$
$\sin\theta = (FH/FB)$
$\sin\theta = \{(2r + (d/2)) \tan\theta/ l_r\}$
$l_r = \{(2r + (d/2)) \tan\theta/ \sin\theta\}$
$\boldsymbol{l_r = \{(2r + (d/2))/ \cos\theta\}}$

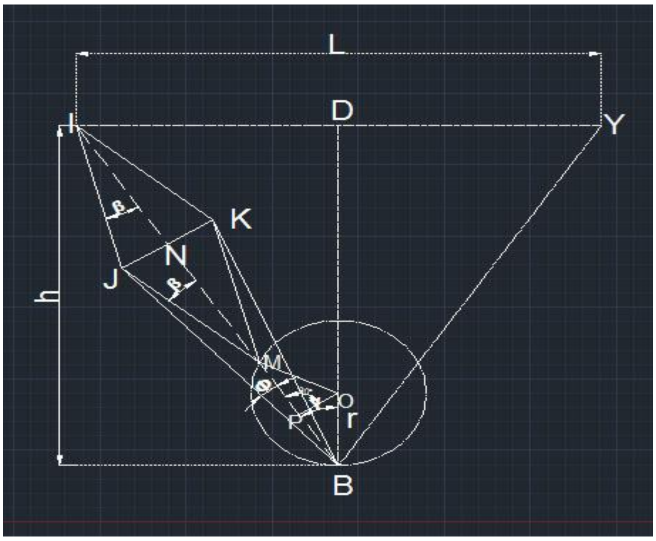

Fig. 2

ASSUMPTIONS:-
1. JN = w is to be assumed for maximum stroke length
Here,
L is the stroke length or overall working length,
2γ is the overall working angle,
l_s is the length of the mechanism at the end points,
2Ø is the angle subtended between the side rods (JB & KB) at the end points
In ΔIJN,
$\sin\beta = (JN/l_b)$
$\boldsymbol{\sin\beta = (w/l_b)}$
$\cos\beta = (IN/l_b)$
$\boldsymbol{IN = l_b \cos\beta}$

$\boldsymbol{IM = 2\times IN}$
In ΔJBN,
$\sin\text{Ø} = (JN/JB)$
$\sin\text{Ø} = (JN/l_r)$
$\boldsymbol{\text{Ø} = \sin^{-1}(IN/l_r)}$
$\cos\text{Ø} = (NB/l_r)$
$\boldsymbol{NB = l_r \cos\text{Ø}}$
$\boldsymbol{l_s = IN + NB}$
In ΔIBD,
$\cos\gamma = (BD/IB)$
$\boldsymbol{\cos\gamma = (h/l_s)}$
$\tan\gamma = \{(L/2)/h\}$

$(L/2) = h \tan\gamma$
$\boldsymbol{L = 2h \tan\gamma}$

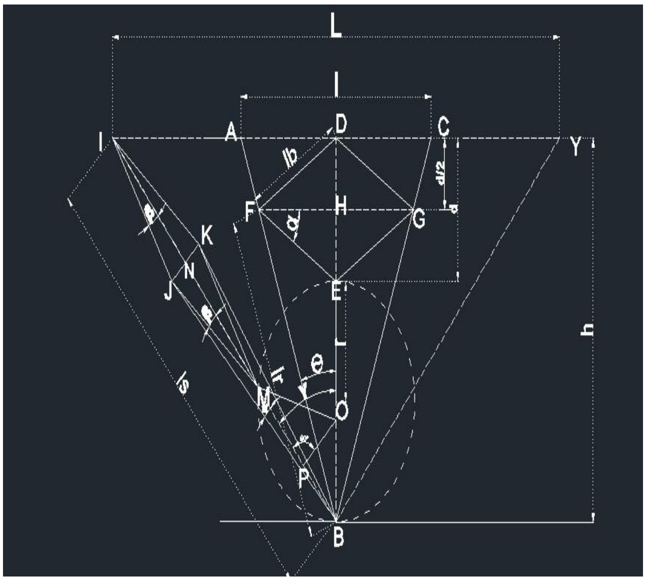

Fig. 3

III. CONCLUSION

This project is all about formulating the relations between the lengths and angles subtended by the linkages of the Peaucellier Mechanism during its motion. The main goal of this project is to provide a proper design procedure for this mechanism so as to minimize the errors occurring during the manufacturing and working of the mechanism and to avoid the usage of hit and trial method for determining the various lengths and working angle of the mechanism. In this project few relations are deduced to calculate the working angle and by knowing the value of the working angle we can easily programthe motor so as to operate the mechanism as per the requirement of the working stroke. Further research on this mechanismcan be done on its optimum utilization by calculating theminimumworking area needed for its antilocking condition at its center and at the end points so as to maximize the stroke length.

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